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Errata

Page 43, line 12, *for* Report. *read* Repert.
Page 96, line 2, *for* not *read* nor.
Page 136, line 13, *for* mount *read* amount.
Page 136, lines 24, 25, and page 137, line 9, *for* colorometric *read* colorimetric.
Page 224, line 11, *for* 45 *read* 40.
Page 225, line 2 from below (in footnote), *for* have not *read* not have.
Page 288, line 12 from below, for *Cladoniar angiferina* read *Cladonia rangiferina*.
Page 289, line 11, for *Philophorus* read *Pilophorus*.
Page 308, line 3, for *rudicaula* read *nudicaule*.
Page 333, line 27, *for* Islands *read* Island.
Page 334, line 19, *for* W. G. Hannibal *read* W. H. Hannibal.
Page 334, line 6 from below, *for* Annie R. Laws *read* Annie E. Laws.
Page 335, line of explanation under table, *for* × not common *read* × not uncommon.
Page 340, first line of footnotes, for *Astropadsis* read *Astrodapsis*, and *for* and other characteristic *read* and characteristic.
Page 372, line 28, *for* Tampico *read* Jacksonville, Tampa.
Pages 426–431, 435, 438, various lines, for *alleghaniensis* read *allegheniensis*.
Page 515, line 5, *for* Withlacooche *read* Withlacoochee.

Vol. 38 No. 1

BULLETIN

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TORREY BOTANICAL CLUB

JANUARY, 1911

Further notes on the stemless violets of the South

EZRA BRAINERD

(WITH PLATE 1)

In the preceding paper* the *palmata* group of blue stemless violets was discussed. Next to these in Dr. Small's Flora of the Southeastern United States comes the *affinis* group, consisting of three closely allied species, growing in wet soil. They are characterized by glabrous foliage, and cleistogamous flowers on ascending peduncles that elongate and bear ellipsoid capsules, more or less tinged or dotted with purple.

VIOLA AFFINIS proves to be a widespread and somewhat variable species. The most marked variation is the pubescent capsule, seen in New England specimens only from Wellesley, Mass., but often in specimens from the Middle States, and collected as far south as Mt. Vernon, Va. This character appears in no other species of our stemless violets, though found in several of the stemmed violets: *V. pubescens*, *V. scabriuscula*, and *V. canadensis*. In all cases it is an inconstant character, being often absent in associated plants otherwise identical.

In the South I collected *Viola affinis* at Summerville, S. C., and found it abundant at Biltmore, N. C. From West Nashville, Tenn., Mr. W. W. Eggleston sent me live plants, that I place here, after growing them for two seasons; though they are somewhat larger than normal in leaf, capsule, and seed.

Specimens of VIOLA LANGLOISII Greene of eastern Louisiana and Texas are not easily distinguished from specimens of *V. affinis*

*37: 581–590. 11 Ja 1911.

[The BULLETIN for December, 1910 (37: 569–630. *pl. 36*) was issued 11 Ja 1911.]

of the North, if one does not know from which region they came. For five seasons the southern plant has been growing out of doors in Vermont, with no winter protection but a covering of leaves; and though not perfectly hardy, and not flowering freely in the spring, yet aside from an indefinable something in its general aspect, I can differentiate it from *V. affinis* by no better earmark than the much greater length of the auricles of the sepals.

However, the southern plant develops a variety with lobed leaves, such as is never found in connection with its northern relative. This in my recent distribution of the violets of eastern North America I have named: *Viola Langloisii* Greene, var. **pedatiloba**, var. nov. As in *V. esculenta*, the lobed leaves are preceded in early spring and followed in late summer by the ordinary uncut leaves.

VIOLA CHALCOSPERMA, the new species of this group from Florida, has the same heterophyllous character, and the same habitat—low tracts often flooded, along sluggish streams.

The third and last group of blue stemless violets in the South may be represented by *Viola cucullata* and *V. sagittata*, and consists of eight species. The group is marked by having subulate or sagittate cleistogamous flowers, on erect peduncles, their capsules always green; the leaves markedly cordate only in *V. cucullata*, usually sharply dentate toward the base or lobed. Two of these species differ from the rest in having the spurred petal glabrous and the lateral petal furnished with a strongly clavate beard. Neither of them is given in the manual of Dr. Small, though VIOLA CUCULLATA is not rare in the southern Alleghanies, and V. VIARUM Pollard is reported for Oklahoma. Mr. B. F. Bush, who sent me specimens from Eagle Rock, southern Missouri, reports that the species is very common along the rocky banks of the White River, which flows southeastwardly for over a hundred miles through the Ozark Hills of northern Arkansas.

Another pair of species—V. FIMBRIATULA and V. VILLOSA—differ from the other six in having a finely pubescent foliage. Both are plants of dry sandy soil. *V. fimbriatula* is rather a northern species, reaching southward along the Appalachian Mountains; while *V. villosa* is strictly southern, and affects the lower levels

of the coastal plains. However, to my great surprise, I found it at three stations, 50 or 100 miles apart, in Oklahoma and Arkansas; and in the Biltmore herbarium I noted a specimen that came from Lufkin, Texas, in 1903.

At Biltmore are also to be seen the aberrant forms of *V. fimbriatula*, on which Mr. Pollard based his *V. amorphophylla*.* The specimens were originally collected by members of the Biltmore staff, and came from Oak Mt., Tryon, N. C., near the Skyuka Hotel (alt. 760 m.)—the only known station. Through the kindness of Mr. C. D. Beadle, one of his assistants was allowed to guide me to the station—a trip of two hours by rail to Tryon, and a three hours drive up the mountain. With *V. amorphophylla* were found several familiar species: *V. cucullata*, *V. palmata*, and *V. fimbriatula*; also the two hybrids, *V. cucullata* × *fimbriatula* and *V. fimbriatula* × *palmata*. The *V. fimbriatula* was the somewhat peculiar form of the southern Alleghanies, having at the base of the leaf on either side one or two long slender teeth or auricles. Intermingled with these, and differing from them only in lack of pubescence, were many young plants of *V. amorphophylla*. The query at once arises, how did this anomalous form originate. Many analogous cases lead me to believe that it is a Mendelian derivative from *V. cucullata* × *fimbriatula*, with which it is still growing—inheriting the leaf form of the one parent species and the glabrous character of the other. In confirmation of this view I would state that at this station were found several plants that had the leaf form of *V. cucullata* × *fimbriatula*, but were unlike it in being perfectly glabrous—another derivative, still hybrid in part. Such a plant may be conveniently called a subhybrid; while a plant like *V. amorphophylla*, wholly rid of the hybridity in its parentage, may be called an ex-hybrid. *V. cucullata* × *fimbriatula* is frequently found in the North, appearing in two forms, according as the parent *V. fimbriatula* has the leaves at the base coarsely toothed or merely crenate-serrate. From a hybrid of the latter form I raised in 1908, and have still in the garden, nine offspring reverting variously, as respects the several pairs of opposed characters found in the grandparents, sometimes to one of them and sometimes to the other, and sometimes to the

*Proc. Biol. Soc. Wash. 13: 129. 1900; Small, Flora of Southeastern U. S. 802.

mother hybrid. Among these nine offspring are two as glabrous as the plant of Mr. Pollard. It is hoped that seeds of the Oak Mt. plants recently sown will another season throw still further light on the status of *V. amorphophylla*.

Viola sagittata and *V. emarginata* constitute another pair of closely allied species; indeed, the latter was originally proposed by Nuttall as a variety of the former. *V. emarginata* grows in much drier soil, and matures wider leaves. It occurs frequently in open woods near Eutaw Springs and Columbia, S. C., and in groves of oak on hillsides at Tryon, N. C.; also abundantly on low hills in the vicinity of Muskogee, Okla. The notched petals that Nuttall observed in the type, and that suggested the name, are rarely found in the plants of the South and West.

Viola sagittata is found through a remarkably wide range—from eastern Massachusetts to southern Louisiana. It is also noteworthy for its inconstancy as respects pubescence. It seems to be normally glabrous; but forms with slight or marked pubescence, like that of *V. fimbriatula*, occur in certain districts of the East, and prevail in the region of the Great Lakes. When these two species grow together, they are generally confluent, not only as regards pubescence, but in length of petiole, in width of leaf, and in sagittate incision at base.* The general situation seems to present a marked instance of an interchange of characters in two allied species through hybridism, continued perhaps from a remote past.†

Viola dentata Pursh has found a place in the Britton Manual as the older name of *V. Porteriana* Pollard,‡ an anomalous plant of not infrequent occurrence in the northern and middle Atlantic States. This in 1904 I interpreted as *V. cucullata* × *fimbriatula*,§ the plant discussed above in connection with *V. amorphophylla*. The identification by Professor Greene of this plant with *Viola dentata* Pursh is based mainly upon its being "quite the same" as an unpublished colored drawing of LeConte's, labeled *V.*

*"Where the two species [*V. fimbriatula* and *V. sagittata*] grow together it is difficult to find the pure species unmixed." Philip Dowell, Bull. Torrey Club **37**: 175. 29 Ap 1910.

† See Rhodora **8**: 57. *pl. 68.* 27 Mr 1906; and Am. Nat. **44**: 233. Ap 1910.

‡ Bull. Torrey Club **24**: 404. *pl. 314.* 1897.

§ Rhodora **6**: 217. 30 N 1904.

emarginata—a plant that LeConte in his paper on *Viola* considers equivalent to *V. dentata* Pursh.* Having seen this beautiful drawing, through the kindness of Professor Greene, I am convinced that it does represent the *V. Porteriana* of Pollard; but equally confident that it is not the *V. dentata* of Pursh. In other words, LeConte confused three distinct things: *V. sagittata*, var. *emarginata* Nuttall, *V. dentata* Pursh, and a hybrid of *V. cucullata* with *V. fimbriatula*. But the error of LeConte was due in part to the earlier errors of Pursh. This pioneer of North American botany knew plants in the field better than in the printed pages of European authors. It is generally acknowledged that his *Viola primulifolia*—"pubescent, flowers blue, sepals ciliate, on dry hills; Canada to Virginia"—is *V. fimbriatula*, the form with uncut basal lobes; and one who reads carefully his descriptions will, I think, be further convinced that his *Viola sagittata*—"*pubescent*, leaves incised at the base, peduncles *longer* than the leaves: on *dry* hills; New England to Virginia"—is also *V. fimbriatula*, the form with coarsely toothed basal lobes; and that his *Viola dentata*—"*glabrous*, leaves subhastately large-toothed below, peduncles *shorter* than the leaves; in *wet* meadows and woods; Pennsylvania"—is simply *V. sagittata* Aiton. Having misapplied the name *V. sagittata*, Pursh had to coin a new name for the plant of Aiton.†

VIOLA SEPTEMLOBA LeConte is very abundant in the pine barrens of the coastal plains from South Carolina to Mississippi; it was well described by its author 85 years ago, and for 25 years found a place in Eaton's Botany, the most widely used manual of that period. Yet subsequently for half a century it suffered a well-nigh total eclipse; until in 1903 it reappeared to the scientific world in Mr. Pollard's account of the southern violets in Dr. Small's manual. It has been often confused with *V. Brittoniana*, a cut-leaved species of the same group and of similar habitat. But they differ strikingly in at least two respects: (1) The seeds of *V. Brittoniana* are buff and 1.6 mm. long; those of *V. septemloba* are dark brown and 2 mm. long. On weighing 200 seeds of

* Pittonia **3**: 256; Bot. Gaz. **26**: 340. 1898.

† The full diagnosis of *Viola dentata* Pursh is: "V. glabra; foliis oblongis acutis basi truncatis serratis inferne subhastato grandi-dentatis, pedunculis foliis brevioribus, calycis laciniis linearibus, petalis 3. inferioribus basi barbatis." Fl. Am. Sept. **1**: 172. 1814.

each, those of *V. septemloba* were found to be 93 per cent. the heavier, or nearly twice as large.* (2) The leaves of *V. Brittoniana* are palmately parted, *all* of the three primary segments being again twice or thrice split; those of *V. septemloba* are pedately parted, the ultimate lobe at the base often runcinately pointed downward. See PLATE 1, FIGURES 3 and 8.†

In accordance with a general rule discussed in the preceding paper, the leaves of *V. septemloba* are also heterophyllous. The older leaves on most plants when in flower are uncut, some of them plainly survivors of an autumn growth. Not infrequently vigorous plants with *all* the leaves uncut are found growing intermingled with normal plants. Specimens of these separated out might easily pass for a different species. Indeed, an intermediate form of *V. septemloba*, with leaves irregularly 3–5-lobed, was published as *V. insignis* by Mr. Pollard in 1898.‡ Because of an earlier use of this name, Professor Greene renamed the plant *V. vicinalis*, recognizing that it was "manifestly related to *V. septemloba*."§

But I find this 3-lobed form constantly associated with the typical form. In scores of large colonies along the Atlantic and Gulf coasts I have found some plants with all the leaves uncut, and some with all the leaves 3-lobed; and sometimes these two leaf forms and the usual 7-lobed leaf occur on the same plant. It seems to me, therefore, that *V. insignis* hardly merits even varietal rank.

VIOLA PEDATIFIDA G. Don is entitled to a place in Dr. Small's Flora, as it occurs not infrequently on the prairies of western Oklahoma. Of all our cut-leaved violets this has a leaf the most pronouncedly multifid; and the cutting is rather on the palmate than on the pedate order, though the name implies the contrary.

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* These two measurements are in close agreement. If we assume that both kinds of seeds have the same form and density, their length having the ratio 2/1.6, their volumes will have the ratio $(2/1.6)^3 = 1.95 +$, making the seeds of *V. septemloba* 95 per cent. the larger.

† Le Conte says of his *V. septemloba*: "It is far more worthy of the name *pedata* than the species to which that name has been applied by general consent." Annals N. Y. Lyceum **2**: 141. 1826.—The primary segments of *V. pedata* are further cleft or incised in a *palmate* fashion. See PLATE 1, FIGURE 6.

‡ Bot. Gaz. **26**: 334, with a good figure.

§ Pittonia **4**: 9. Ja 1899.

The leaf is primarily three-parted, and when well developed each of the three segments is further trisected, and then each of these subdivisions once more cut into 2–4 lobes. (See PLATE I, FIGURE 2.) In the smaller leaves and in those that appear in summer the lateral primary segments are often imperfectly or obscurely trisected and seem to be somewhat irregularly pedate; and this fact doubtless suggested the inappropriate name of the species. In *V. pedatifida* the middle segment is never uncut, as in leaves strictly pedate, but is even more dissected than the lateral segments.

Synopsis of cucullata-sagittata group of blue stemless violets

Spurred petal glabrous, lateral with clavate beard.	
Leaves uncut, broadly cordate-ovate.	*V. cucullata.*
Leaves pedately lobed or parted.	*V. viarum.*
Spurred petal villous at base, lateral with capillary beard.	
Foliage finely pubescent.	
Leaves ovate-oblong, acute.	*V. fimbriatula.*
Leaves ovate to orbicular, obtuse.	*V. villosa.*
Leaves oblong-lanceolate, incised at base.	*V. sagittata.*
Foliage nearly or quite glabrous.	
Leaves oblong-lanceolate, incised at base.	*V. sagittata.*
Leaves deltoid to broadly ovate, coarsely toothed at base.	*V. emarginata.*
Leaves uncut or pedately 3–9-lobed.	*V. septemloba.*
Leaves palmately cut into 9–30 lobes.	*V. pedatifida.*

All the species of white stemless violets found in the North, except *Viola renifolia*, are found also in the territory embraced in Dr. Small's Flora; and in addition one not found in the North, *V. vittata* Greene. But only two of the northern species, *V. lanceolata* and *V. primulifolia*, are widely distributed in the South —*V. pallens*, *V. blanda*, and *V. incognita* being restricted there to the upland region of the southern Alleghanies.

In this group pubescence proves to be an inconstant character. VIOLA PRIMULIFOLIA, which in the extreme North is quite glabrous, becomes more and more pubescent as we go southward, untili n the Gulf States it is often densely villous on the petiole and lower leaf surface. This variety was first noted by LeConte, and named var. *villosa* by Amos Eaton, when he adopted in his Manual LeConte's treatment of the genus. Mr. Pollard's var. *australis* seems to cover the same ground.

VIOLA VITTATA Greene (*V. denticulosa* Pollard), an odd species with long linear leaves, is at times almost glabrous, and seems

to have been so in the type specimens, as the author makes no mention of any pubescence. But usually more or less hairiness appears on the petioles and lower leaf surfaces, and they are sometimes densely villous.

VIOLA BLANDA Willd. is glabrous except for scattered white hairs on the upper surface of leaves that unfold at flowering. But in Tryon, N. C., I found a colony without a trace of white hairs; and plants transferred to the garden, and their offspring, have continued perfectly glabrous.

The type of VIOLA RENIFOLIA Gray is markedly pubescent throughout; but the more common form has at least the upper leaf surface glabrous, and has been published as a species, *V. Brainerdii*, by Professor Greene.* But the difference between the two plants, though perhaps worth naming, is not specific, according to my conception of species.

VIOLA INCOGNITA Brainerd is also inconstant as respects pubescence. The type has "peduncles, petioles and lower surface of leaves pubescent with soft white hairs especially when young, the upper leaf surface glabrous or nearly so."† But in low moist woods nearly glabrous forms are frequent, usually with minute white hairs on the upper surface of the later leaves, as in *V. blanda*. Though in all other characters these two forms are identical, yet I find their marked difference in pubescence has been a source of confusion to students of *Viola*: and I would therefore distinctly mark off this form, as

Viola incognita, var. **Forbesii**, var. nov. Nearly or quite glabrous, except often for scattered white hairs on the upper leaf surface; otherwise like the type. A common form in moist woodlands, from eastern Quebec westward to Wisconsin, and southward to the mountains of eastern Tennessee.

All forms of *V. incognita*, except certain hybrids, differ from *V. blanda* Willd. in having at maturity broader leaves with deeper and wider sinus at the base, in having the lateral petals bearded, the upper petals obovate and not porrect, and in flowering a week or two earlier. But the most marked difference appears in the seeds, which in *V. incognita* are obtuse at base, brown, smooth,

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*Pittonia 5: 89. 1902.

†Rhodora 7: 248. 31 D 1905.

2 mm. long; and in *V. blanda* acute at base, dark brown, minutely rugose, 1.5 mm. long. The accompanying figure is given to bring out these differences, and incidentally to illustrate the diagnostic value of seed characters in *Viola*.

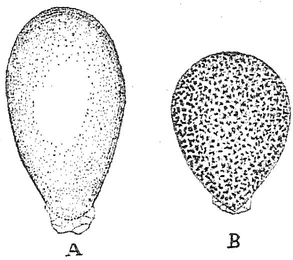

FIGURE 1. *A*, a seed of Viola incognita; *B*, a seed of Viola blanda; × 15.

MIDDLEBURY, VERMONT

Explanation of plate I

All the figures $\times \frac{2}{3}$

1. *Viola palmata* L. Lake Co., Fla. 2. *V. pedatifida* G. Don. Muskogee, Okla. 3. *V. Brittoniana* Pollard. Dedham, Mass. 4. *V. Egglestonii* Brainerd. West Nashville, Tenn.	Palmately cut.
5. *V. triloba* var. *dilatata* (Ell.) Brainerd. Mansfield, La. 6. *V. pedata* L. Terra Cotta, D. C. 7. *V. esculenta* Ell. Jacksonville, Fla. 8. *V. septemloba* LeConte. DeLand, Fla.	Pedately cut.

Studies on the Rocky Mountain flora — XXV

PER AXEL RYDBERG

Ptilocalais macrolepis Rydb. sp. nov.

Perennial with fusiform roots; stem glabrous, 2–5 dm. high, somewhat branched, glabrous or minutely puberulent; lower leaves somewhat petioled, the upper sessile; blades linear-lanceolate, entire or rarely pinnatifid with linear-lanceolate, divergent divisions; heads solitary at the ends of the slender naked branches; involucres turbinate, about 2 cm. high. Calyculate bracts 8–10, lanceolate or linear-lanceolate, 3–6 mm. long; bracts proper 12–15, linear-lanceolate, attenuate; achenes about 7 mm. long, puberulent on the rounded angles or glabrate; pappus-scales lanceolate, 4–5 mm. long, gradually tapering upwards; bristles 6–7 mm. long.

In habit this species is intermediate between *Ptilocalais nutans* and *P. major*, with the head of the latter, but it differs from both in the pappus-scales. In the original description of *Ptilophora major*, Gray gives no description of the pappus, stating that his specimens were too young. In the Columbia University herbarium there is a duplicate of the type, collected by Spalding. This has fairly well developed fruit and shows that *Ptilocalais major* has practically the same pappus as *P. nutans*, i. e., the paleaceous portion is only 2 mm. long, oblong in outline, truncate and somewhat 3-toothed at apex. *P. macrolepis* grows in sandy soil at an altitude of 1200–1500 m.

UTAH: Benches near Salt Lake City, Apr. 30, 1904, *A. O. Garrett 182* (type, in herb. N. Y. Bot. Gard.); Red Rock Cañon, June 11, 1905, *Rydberg 6105;* Salt Lake City, May 12, 1880, *M. E. Jones 1707* (at least in part); benches near Salt Lake, June 1, 1900, *Stokes.*

PTILORIA

Professor Nelson, in the New Manual of Botany of the Central Rocky Mountains, restores the name *Stephanomeria*, following the Vienna Rules. The only criticism I have to make of the treatment of the genus is that he has reduced *Ptiloria ramosa*

Rydb. to a synonym of *S. tenuifolia* (Torr.) Hall. In the herbarium of the New York Botanical Garden there is a good specimen of *P. ramosa* collected by Aven Nelson and Elias Nelson, viz., *no. 5985*. This is labeled *Ptiloria pauciflora* (Torr.) Raf. It agrees well with Nelson's description of *S. pauciflora*, except as to the pappus, but it is very unlike the type of *Prenanthes pauciflora* Torrey, collected by James and preserved in the herbarium of Columbia University. *Ptiloria pauciflora*, so far as I know is not found so far north as Wyoming.

ADOPOGON

Professor Nelson has readopted *Krigia* for this genus and perhaps rightly so, as most of Necker's genera can scarcely be called published. However, he wrongly adopts the name *Krigia virginica* (L.) Nels. for the only species found in the region, notwithstanding the fact that there is an older *Krigia virginica* (L.) Willd.

CREPIS

Under *Crepis runcinata* we find in the New Manual the following synonyms and remarks. "(*C. platyphylla* Greene . . . ; *C. glaucella* Rydb. . . . , *C. tomentulosa*, *C. perplexans*, and *C. petiolata* Rydb. . . . To recognize the foregoing one would first have to assume a hypothetical *C. runcinata*.)" There is hardly need of assuming a hypothetical *C. runcinata*, for there are found in the region where the type of *Hieracium runcinatum* Torr.* was collected at least two plants which agree very well with the original description. One is the plant for which I have adopted the name *Crepis runcinata*, the other is *C. riparia* A. Nels. Most of James' plants are in the old Torrey herbarium, but the type of *Hieracium runcinatum* is not there. Torrey's description is very clear, however, and calls for a strongly hairy plant. All the synonyms cited above, except *C. platyphylla*, represent glabrous plants (except as to the involucres), and more closely related to *C. glauca* than to *C. runcinata*. *Crepis platyphylla* Greene is closely related to *C. riparia* and perhaps not distinc ,

*Ann. Lyc. N. Y. 2: 209. 1826.

at least it is more closely related to it than is *C. denticulata* Rydb., which Professor Nelson reduces to a variety. A "conservative" botanist would unite *C. platyphylla* Greene (*C. runcinata hispidulosa* Howell) and *C. riparia*. The latter would then be reduced to synonymy, as the form r name is three years older In Torrey and Gray's Flora, *Hieracium runcinatum* was transferred to *Crepis* and the authors cite four specimens, of which two, viz., those collected by Drummond (*Crepis biennis* β Hook.*) and by Nicollet are preserved in the Torrey herbarium. These agree with the description of Torrey's *Hieracium runcinatum*. I have adopted the name *Crepis runcinata* for these specimens rather than to transfer the name to *C. riparia*. If Professor Nelson had reduced *C. tomentulosa* to a synonym of *C. glauca*, I would have made no objection, for I myself am somewhat suspicious that it may be only a state or condition of that species. *Crepis petiolata* and *C. glauc lla* are closely related to it, and the glandular involucre is the only character which would associate it with *C. runcinata*. *C. perplexans* is closer to *C. runcinata*, but it also is a glabrous plant.

Both *Crepis denticulata* Rydb. and *C. alpicola* A. Nels. are included in *C. riparia parva* A. Nels. *Crepis alpicola* was technically based on *C. runcinata alpicola* Rydb. The type of both the latter and *C. denticulata* are in the herbarium of the New York Botanical Garden and they are not at all alike. Nelson's description of *C. riparia parva* agrees with *C. alpicola* but not with *C. denticulata*. Compare the original descriptions.

Crepis angustata Rydb. is made a synonym of *C. gracilis* (D. C. Eaton) Rydb. The plant described by Professor Nelson is, however, not *C. gracilis* but *C. angustata*. *Crepis gracilis* was established on *C. occidentalis gracilis* D. C. Eaton.† The type of this is *Watson 716*, a duplicate of which is in the Columbia University herbarium. It is a plant exceedingly like *C. scopulorum* in habit, but the involucre is narrower, the bracts fewer, and the achenes distinctly ribbed. Some of the involucral bracts have a few black hairs as they have in *C. scopulorum*. *Crepis angustata*, like *C. intermedia*, never has black hairs. *C. gracilis*

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*Fl. Bor.-Am. 1: 297.

†Bot. King. Exp. 203. 1871.

I think has been redescribed under the name *C. exilis* Osterhout,* omitted by Nelson.

Crepis pumila Rydb. is made a synonym of *C. occidentalis*. *C. pumila* is not only a lower plant, without any trace of black glandular hairs, but it has different, perfectly columnar achenes. Apparently it was included by Dr. Gray in his *C. occidentalis costata*.

Crepis atribarba Heller is made a synonym of *C. barbigera* Leiberg. The two are not even closely related. The latter is not found within the region, and there was no need of even considering it.

Crepis seselifolia sp. nov.

Perennial with an ascending rootstock and short base covered by remains of old leaves; stem 4–6 dm. high, slender, canescent-tomentulose or the upper part glabrous; basal leaves long-petioled; blades 1–2 cm. long, deeply twice pinnatifid, with linear filiform divisions, canescent-tomentulose, caudate-acuminate, with an elongated linear entire end 5–8 cm. long; stem-leaves subsessile, less divided or the uppermost entire and linear-filiform; heads corymbose-paniculate; involucre glabrous, cylindric, about 1 cm. long; calyculate bracts ovate or ovate-lanceolate, only 1–1.5 mm. long; bracts proper 5–7, linear, yellowish green; flowers 5–7; ligules nearly 1 cm. long; achenes somewhat fusiform, striate.

In habit this species resembles most *Crepis gracilis* (D. C. Eaton) Rydb., but the divisions of the leaves are much narrower and often again divided into very narrow divisions, and the involucre is glabrous as in *C. acuminata*. The leaves resemble those of certain species of the genus *Seseli*.

IDAHO: Rocky hillsides, scarce, valley of Big Potlatch River, Nez Perces County, Idaho, June 6, 1892, *Sandberg, MacDougal & Heller 326* (type, in herb. N. Y. Bot. Gard.).

HIERACIUM

Professor Nelson includes both *Hieracium umbellatum* L. and *H. canadense* Michx. in the flora of the Rocky Mountains. Neither is found in the region. *H. umbellatum* is exceedingly rare in America and confined to the extreme northeastern part, evidently an introduced plant. *H. columbianum* on account of its

* Muhlenbergia 1: 142. 1906.

narrow leaves (narrower than in *H. canadense*) has sometimes been confounded with *H. umbellatum*, sometimes with *H. canadense* on account of its hairy stem. The common plant of the West, which has been confounded with both, is *H. scabriusculum* Schwein.* (*H. macranthum* Nutt.†). Narrower-leaved specimens have been named *H. umbellatum* and broader-leaved ones, *H. canadense*. It differs from *H. canadense* in the glabrous stem and finely scabrous-puberulent leaves. *H. columbianum* has long white or yellow hairs on the lower part of the stem.

The true *Hieracium Scouleri* Hook. is not found in the region. A duplicate of the type is in the old Torrey herbarium. It is an almost scapose plant with the broad leaves obtuse at the apex and gathered near the base of the stem. The stem-leaves are few and small and the involucral bracts hirsute with short dark hairs. The plant resembles more *Hieracium albiflorum* in habit than it does *H. griseum* and *H. cynoglossoides*. The plant with long-hairy involucre which, mainly, Dr. Gray described in his Synoptical Flora and Professor Nelson described in the New Manual is not *H. Scouleri*. It should be known as *H. albertianum* Farr.‡

Heteropleura Fendleri (Schultz Bip.) Rydb. comb. nov.

Crepis ambigua A. Gray, Mem. Am. Acad. 4: 114. 1849. Not *C. ambigua* Balb. 1805.
Hieracium Fendleri Schultz Bip. Bonplandia 9: 173. 1861.
Heteropleura ambigua Schultz Bip. Flora 45: 435. 1862.
Hieracium nigrocollinum S. Wats. Proc. Am. Acad. 25: 133. 1890.

This species has been included in *Hieracium* by Dr. Gray and others. It would be better to include it in *Crepis* than in *Hieracium*, for the achenes are tapering upwards and the pappus is tawny, not white. The involucral bracts are not thickened on the back, however, as they are in most species of *Crepis*, and the general habit resembles perhaps more that of *Hieracium* than of *Crepis*. It does not fit well in either genus, at the same time

*Long's Second Exp. 2: 394. 1824.
† Trans. Am. Phil. Soc. II. 7: 446. 1841.
‡ Ottawa Nat. 20: 109. 1906.

combining characters of both. Either the two genera should be united or else this species and several others of the southwestern United States and Mexico should be separated as a distinct genus. Even Fries in his Symbolae Hieraciorum recognized this fact and suggested the name *Crepidispermum*. He did not exactly publish the genus and no binomial names were given under the genus. Besides, in the same year a genus *Crepidospermum* B. & H. was published. The two names differ only in one letter, the connecting vowel *i* in one case and *o* in the other. The former is the Latin connecting vowel, the latter the Greek, which is sometimes used in Latin for euphony's sake. The two names may therefore be regarded as identical. The two brothers Schultz of Zweibruecken adopted Fries' suggestion and established the genus under the name *Heteropleura*, as alternate ribs of the achenes are stronger. The present species was given the name *Heteropleura ambigua*, based on *Crepis ambigua* A. Gray. As there is an older *C. ambigua* Balb., that specific name is not available, and hence I have adopted *Heteropleura Fendleri*.

AGOSERIS

Professor Nelson reëstablishes the name *Troximon* for this genus, evidently following as he thought the Vienna Rules and cites Nuttall as authority for the genus. This is a similar case to that of *Actinella* and *Tetraneuris*. In fact Nuttall never established a genus *Troximon*. He thought that his two species belonged to the genus *Troximon* Gaert. *Troximon* of Gaertner was established in 1791 on *Tragopogon Dandelion*, *T. virginicum*, and *T. lanatum*, of which the first two belong to one genus, *Krigia* or *Adopogon*, and the last is a *Scorzonera*. Even if Nuttall had established a genus *Troximon*, this would not hold, for then it was not published before 1818 in his Genera, while Rafinesque's name dates from 1817. It is true that *Troximon* appeared in Fraser's Catalogue of 1813, but there it is without description. In his Genera, Nuttall credits Gaertner with the name. So does also Pursh in his Flora, 1814. There is therefore no warrant for reviving *Troximon* for the genus known in later years as *Agoseris*.

A good deal may be said regarding Professor Nelson's treatment of this genus, especially in the way synonyms have been

cited. *Agoseris attenuata* Rydb. is given as a synonym of *T. pubescens* (Rydb.) A. Nels. *A. attenuata* has perfectly glabrous leaves, only the involucre and the upper part of the scape being villous. It would be included in *Agoseris pumila* (Nutt.) Rydb., were it not for the decidedly acuminate inner bracts. It has very little indeed to do with the decidedly pubescent *A. pubescens*.

Agoseris maculata Rydb. is made a synonym of *Troximon villosum* (Rydb.) A. Nels. It is true that they much resemble each other in general habit and pubescence, but the outer bracts in *A. villosa* are obtuse or even rounded at the apex, while those of *A. maculata* are abruptly and distinctly acuminate. *A. villosa* is a plant of the lowlands of Montana, westward and northward, while *A. acuminata* is an alpine or subalpine plant of the mountains of Colorado.

Troximon roseum Nutt., *Agoseris agrestis* Osterhout, and *A. roseata* Rydberg are made synonyms of *Troximon glaucum*. I have not seen the type of *T. roseum* Nutt., but, as I interpret it, it is a plant closely related to *T. laciniatum* Nutt., not to *T. glaucum*. *Agoseris agrestis* Osterhout is related to *A. glauca*, but if made a synonym of anything it should be of *Troximon pumilum* Nuttall, having the same pubescent involucral bracts, but the leaves are pinnatifid and caudate-acuminate instead of entire and obtuse or rounded at the apex.

Under *Troximon glaucum dasycephalum* Professor Nelson gives a citation from Piper's Flora of Washington: "This plant differs from *T. glaucum* only in having a pubescent involucre. It is scarcely worth nomenclatural recognition." I think that both Piper and Nelson are incorrect in this statement. In *Agoseris glauca* (Nutt.) Greene the involucre is decidedly obconic, and the leaves narrowly oblanceolate or linear and glaucous; in *Agoseris scorzoneraefolia* (Schrad.) Greene (*Troximon glaucum dasycephalum* T. & G.) the involucre is decidedly campanulate, sometimes in age almost hemispheric, the outer bracts and the leaves broader, and the latter scarcely glabrous. Those who have access to the Botanical Magazine may compare *plate 1667* and *plate 3462*, which give good illustrations of *Agoseris glauca* and *A. scorzoneraefolia* respectively.

Under *Troximon glaucum dasycephalum*, *Agoseris altissima* is

given as a synonym. The latter plant is a decidedly pubescent plant and should be associated rather with *A. villosa*, but is taller and its flowers turn deep purple in age.

Under the variety *pumilum* we find *Agoseris Leontodon* Rydb. as a synonym. The latter was based on *Macrorhynchus glaucus laciniatus* D. C. Eaton. Dr. Gray included in his *Troximon glaucum laciniatum* a multitude of forms, in fact everything of the *A. glauca* group with laciniate leaves. *Macrorhynchus glaucus laciniatus* D. C. Eaton is not found east of Nevada. It is related to *Stylopappus laciniatus* Nutt.

Under *Troximon arachnoideum* (Rydb.) A. Nels. are found the following: "*T. glaucum laciniatum* in part (not *T. laciniatum* Gray . . . ; *Agoseris laciniata* Greene; *A. arachnoidea* Rydb. . . .)." The plant described by Professor Nelson is the same as *Stylopappus laciniatus* Nutt. A duplicate of Nuttall's type is in the old Torrey herbarium, and it is to be known as *Agoseris laciniata* (Nutt.) Greene. If *Troximon* is used the name should be *T. laciniatum* (Nutt.) A. Gray, although Dr. Gray described under that name an entirely different plant from Nuttall's *Stylopappus laciniatus*. The type of the latter did not have developed fruit and both Nuttall and Gray thought that it was related to *Stylopappus grandiflorus* Nuttall, or *Troximon grandiflorum* A. Gray. Its achenes are of the *A. glauca* type with short striate beak. (See further below.) To use the name *Troximon arachnoideum* for this plant was entirely out of place, for *Agoseris arachnoidea* Rydberg is an entirely different plant of the *A. aurantiaca* group, with long filiform, non-striate achene-beak, in age purple flowers, and with densely pubescent leaves. Evidently Professor Nelson did not know the plant.

Under *Troximon purpureum* we find the following synonyms: "*Macrorhynchus purpureus* A. Gray . . . ; *T. gracilens* A. Gray . . . ; *A. Greenei* Rydb. as to our range." In the herbarium of Columbia University there is a duplicate of the type of *Macrorhynchus purpureus* A. Gray. It is a low plant scarcely more than 1 dm. high, with narrow, pinnatifid, glaucous and glabrous leaves and brightly spotted involucral bracts. Professor Nelson characterizes his *Troximon purpureum* as being tall, 2–5 dm. high, with leaves tapering into long, slender, winged petioles. Evi-

dently Professor Nelson did not have in mind the true *Macrorhynchus purpureus*, on which *Troximon purpureum* (A. Gray) A. Nels. should have been based, but a mixture of *A. gracilens* and *A. Greenei* Rydb. If any reduction should have been made, *T. gracilens* should have been made a synonym of *Troximon aurantiacum* Hook. In the herbarium of Columbia University there is a duplicate of the type of the latter and one specimen cited in the original description of the former. The only difference I can see is that the outer bracts in *T. aurantiacum* are broader and inclined to be obtuse. As to *Agoseris Greenei* Rydb. the name has to be changed. The plant should be known as

AGOSERIS GRAMINIFOLIA Greene, Bull. Torrey Club 25: 124. 1898.

Troximon gracilens Greenei A. Gray, Proc. Am. Acad. **19**: 71. 1883.

Agoseris gracilenta Greenei Greene, Pittonia **2**: 177. 1891.

Agoseris Greenei Rydb. Mem. N. Y. Bot. Gard. **1**: 459. 1900. Not *Agoseris Greeneana* O. Kuntze, Rev. Gen. Pl. 304. 1891.

Troximon purpureum A. Nels., Coult. & Nels. New Man. Cent. Rocky Mts. 599, in part. 1909. Not *Macrorhynchus purpureus* A. Gray. 1859.

For this species I had adopted the name *Agoseris Greenei*, basing it upon *Troximon gracilens Greenei* A. Gray, but I had overlooked the fact that there had been published an *Agoseris Greeneana* based on *Troximon elatum* Greene. The latter should be known, however, as *A. major* Jepson, published in September, 1891, while Kuntze's name was published in October, 1891.

A closer investigation of *Agoseris graminifolia* persuaded me that it could not be kept distinct from *A. Greenei* (A. Gray) Rydb. although the leaves of the specimens from type collection are more entire than usual. On the sheet in the collection of the New York Botanical Garden they are wholly entire, but the figure published and drawn from the type specimen shows four leaves with a few short lobes.

Under *Troximon arizonicum* Professor Nelson gives as synonyms *Agoseris elongata* Greene, *A. rostrata* Rydb., and *A. humilis* Rydb. The first is only a manuscript name, but the specimens so named are rightly referred to *T. arizonicum*. *Agoseris humilis*

is related to *A. gracilens* and *A. aurantiaca* and should have been included in the latter as characterized by Professor Nelson. *Agoseris rostrata* is not closely related to either but is the next relative to *A. grandiflora* of the Pacific Slope, having the same short outer bracts and elongated inner ones and the same very long and slender beak of the achenes, nearly three times as long as the body. It is the "*T. grandiflorum* as to our range," an expression which Professor Nelson erroneously uses under *Troximon montanum*.

Agoseris turbinata sp. nov.

Perennial with taproot and short caudex; leaves narrowly linear, 7–15 cm. long, 1–5 mm. broad, glabrous, bluish green, the midvein and base often purplish, entire, attenuate; scape about 3 dm. high, slender, sparingly villous, more densely so under the head; involucres turbinate, 17–20 mm. high; bracts all narrowly lance-linear, villous on the back as well as on the margins, with dark purple middle and yellowish green margins; ligules 15–18 mm. long, yellow with purplish veins, turning pinkish in age; beak of the achenes short and striate.

This resembles in many respects *Agoseris parviflora* in habit, but differs in the villous scape and involucre and in the beautifully variegated bracts.

ALBERTA: Gravel Slope of Tunnel Mountain, *McCalla 2063* (type, in herb. N. Y. Bot. Gard.).

Agoseris obtusifolia (Suksd.) Rydb. nom. nov.

Troximon grandiflorum obtusifolium Suksd. Deuts. Bot. Monats. 18: 98. 1900.

This is characterized by the broad oblong obtuse lobes and the obtuse or even rounded apex of the leaves. I think that it deserves specific rank. It has been collected in western Idaho.

Agoseris tenuifolia (A. Gray) Rydb. nom. nov.

Troximon grandiflorum tenuifolium A. Gray, Bot. Calif. 1: 438, in part. 1876.

Troximon laciniatum A. Gray, Proc. Am. Acad. 19: 72, in part. 1883. Not *Stylopappus laciniatus* Nutt. Trans. Am. Phil. Soc. II. 7: 432. 1841.

In the Botany of California Gray gives a short description of

Troximon grandiflorum tenuifolium, and points out the characters distinguishing it from *T. grandiflorum*. He gives as a synonym *Stylopappus laciniatus longifolius* Nutt., but a duplicate of the type of the latter collected by Douglas is in the Columbia University herbarium and in this specimen the outer bracts are not dilated as they are in *A. grandiflora* and its relatives.

In the Proceedings of the American Academy, vol. 19, Dr. Gray adopts the name *Troximon laciniatum*, giving as synonyms *Stylopappus laciniatus* Nutt. and its variety *longifolius*; also *Troximon grandiflorum* var. *tenuifolium* and var. *laciniatum* of the Botany of California. A duplicate of Nuttall's type of *Stylopappus laciniatus* is also in the Columbia University herbarium. In later years many specimens matching this specimen have been collected in Wyoming, Colorado, Utah, and Idaho. This is a species with achenes of the type of *Agoseris glauca* and was probably included in Gray's *Troximon glaucum laciniatum*, but it is not *Macrorhynchus glaucus laciniatus* D. C. Eaton. In my Flora of Colorado, I adopted the name *Agoseris laciniata* (Nutt.) Greene for this species. Professor Aven Nelson describes it in the New Manual as *Troximon arachnoideum* (Rydb.) A. Nels. It has nothing to do with *Agoseris arachnoidea* Rydb. See above, p. 18.

TARAXACUM

Professor Nelson's treatment of *Taraxacum* is good. He acknowledges six species, instead of only one as Dr. Gray did. The only criticism I have to offer is that *Taraxacum leiospermum* Rydb. is made a synonym of *T. angustifolium* Greene. It is true that in both the lower part of the achenes is smooth, but otherwise there are several discrepancies between the descriptions of the two. *T. angustifolium* is characterized as having narrow, oblong-linear leaves, and the outer bracts few and small, in a single series, and erect, while in *T. leiospermum* the leaves are broadly oblanceolate and the calyculate bracts are in 2 or 3 series and with spreading tips, as in *T. dumetorum*.

LACTUCA L.

Professor Nelson has given a new specific name to the more common prickly lettuce of the Rocky Mountain region. It has

usually been known as *Lactuca Scariola* L., which name has included all the prickly lettuces found introduced in North America, viz., *L. Scariola* L., *L. virosa* L., *L. saligna* L., etc. The plants with merely toothed leaves were referred to *L. virosa* L. by Dr. N. L. Britton, but Mr. L. F. Dewey of the United States Department of Agriculture contends that it is not *L. virosa* but *L. Scariola integrata* Gren. & Godr. Mr. Dewey is followed by Robinson & Fernald in Gray's New Manual. So also by Professor Nelson, but he regards it as specifically distinct from *L. Scariola* and proposes the name *L. integrata* (Gren. & Godr.) A. Nels. This was altogether unnecessary for *L. Scariola integrata* Gren. & Godr.* was based on *L. augustana* All.† Allion gives a good figure.

Linnaeus in his first edition had only one species, *Lactuca virosa*, with three varieties. In the second edition *L. Scariola* is adopted for *L. virosa* var. δ of the first edition. Both *L. virosa* and *L. Scariola* are based on figures in Morison's Historia, and the figure cited under *L. virosa* resembles indeed very much the more common plant introduced in the Rocky Mountain region, much more so than Allioni's plate of *L. augustana* does. The difference between *L. virosa* and *L. Scariola* given by Linnaeus is that the former has toothed horizontal leaves while in the latter they are pinnatifid and vertical. The plant answering the description of *L. Scariola* has been collected in Utah and Montana but the plant with merely toothed leaves is more common. Mr. Dewey's contention may be correct as far as the plant around Washington and Boston is concerned, but I think the plant of the Rockies and the Pacific Slope is *L. virosa*. So far as I know, the leaves are not turned on edge as they are in *L. Scariola* and Professor Nelson describes the achenes of his *L. integrata* as being dark-colored instead of pale. Dewey described the achenes of *Lactuca virosa* as being darker and broader than in *L. Scariola*, while he could not find any differences between those of the latter and the var. *integrata*. There is another character which helps to distinguish *L. virosa* and *L. Scariola*. In the latter, the branches of the panicle are inclined to be racemiform, while in *L. virosa* they are more branched with more or less diverging branchlets.

*Fl. Tran. 320. 1850.

†Fl. Pedem. 1: 224. 1785.

The Rocky Mountain specimens agree in this respect with *L. virosa*. They have also the obtuse lower leaves of that species as figured by Morison, as illustrated in Sweet's English Botany, in Baxter's British Phaenogamous Botany, and in the Flora von Deutschland. Allioni's illustration of *L. augustana* shows only the upper part of the plant, but all the leaves shown are decidedly acute.

Lactuca polyphylla sp. nov.

Biennial; stem stout, about 1 m. high, glabrous; leaves sessile and slightly auriculate-clasping, very numerous, linear-lanceolate, entire, acuminate, 1–2 dm. long, glabrous, not at all spinulose; panicle conical, much branched, about 3 dm. long, 1.5 dm. broad; involucres about 1 cm. high; outer bracts lanceolate, about half as long as the linear-lanceolate inner ones; achenes nearly black, 3–4 mm. long, oval, indistinctly 3-nerved, transversely rugose; beak about 2 mm. long.

The type was determined as *Lactuca integrifolia* Bigel., but it differs from that purely eastern species in the numerous more willowlike leaves, the stout stem, the numerous heads in a more compact panicle and the short beak of the achenes.

IDAHO: Lake Pend d'Oreille, Aug. 5, 1885, *E. L. Greene* (type in herb. Columbia Univeristy).

NEW YORK BOTANICAL GARDEN,
BRONX PARK, NEW YORK CITY

Some common species of Crataegus at Thompson's Mills, Georgia

H. A. Allard

Within the confines of the little settlement of Thompson's Mills, several handsome species of *Crataegus* are very abundant. Within a stone's throw of the settlement, on a pasture hillside covered mainly with a heavy growth of tall pines, the underbrush consists almost entirely of various species of *Crataegus*, one of which, *Crataegus Beadlei* Ashe, has not before been reported for Georgia. In this particular lot, which has been pastured to hogs and stock for a long time, the profusion and vigor of the various intermingling species seems to depend largely upon the noticeable enrichment of the soil and its thorough cultivation, so to speak, by the great number of hogs that are kept on this enclosure. *Crataegus Crus-galli* L., *C. spathulata* Michx., *C. uniflora* Muench., *C. collina* Chapman, and *C. Beadlei* Ashe were everywhere in evidence.* Concerning the habits of growth and ornamental characteristics of these species the writer has made notes, from time to time, which may be of some interest to those studying the *Crataegus* group in Georgia.

Crataegus Crus-galli L. This is one of the commonest and most ornamental thorns in the Thompson's Mills region. It is found in woods and in open fields. The finest and most symmetrical specimens are found on pasture hillsides, where they become profusely branched trees twenty feet or more in height. About May 1 in this region, this *Crataegus* bursts suddenly into bloom and becomes whitened with numerous clusters of fragrant blossoms about 0.5 inch in diameter. Each corymb contains from 10–25 white blossoms. These corymbs, about 1.5 inches across, are exceedingly abundant on some shrubs and are subtended by rosettes of rich, dark green shining leaves which seem to heighten both colors by their striking contrast. The pink or rose-colored

*The species of *Crataegus* mentioned in this paper were identified through the kindness of W. W. Eggleston, of the U. S. Dept. of Agriculture, Washington, D. C.

anthers likewise add to the attractiveness of the flowers. The odor of the blossoms is pearlike, permeating the woods around, and attracting swarms of bees and wasps.

The leaves are usually obovate or oblanceolate and finely serrate from the middle to the obtuse or almost truncate apex. On the upper surface they are very dark shining green as if varnished; beneath paler and smooth throughout. Formidable thorns are developed in great abundance; they are strong, sharp and slender, and range from 1.5 to 2 inches in length.

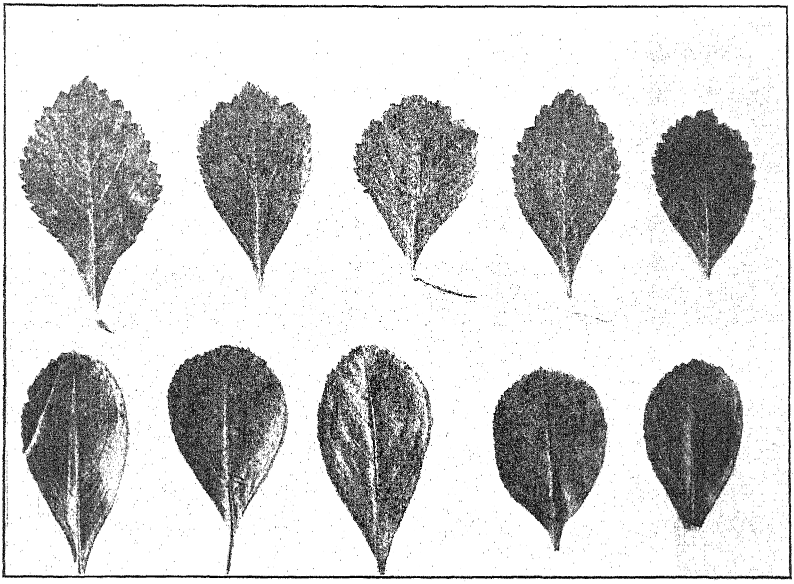

FIGURE 1. Upper row, leaves of *Crataegus uniflora*; lower row, leaves of *C. Crus-galli*; about four fifths natural size.

The corymbs of this *Crataegus* usually burst into bloom almost simultaneously, and a day or two later the white petals are falling in showers like snowflakes.

The fruit of *C. Crus-galli*, which is more or less oval in shape, ripens late in October. During the season of 1910, the fruit of this thorn was still green or only slightly reddened on one side on October 18. When ripe the color is a pale red. The abundant foliage is shed early. During the season of 1910 defoliation was complete before the middle of October, although the green fruit

was still retained. This *Crataegus* fruits abundantly in enriched soils, but is oftentimes quite barren on sterile, rocky hillsides. It is a common pasture species on the plantation of the J. N. Thompson Co., and is the favorite nesting site of the mocking bird in this region.

CRATAEGUS SPATHULATA Michx. This is a very common species in various situations at Thompson's Mills. It occurs in

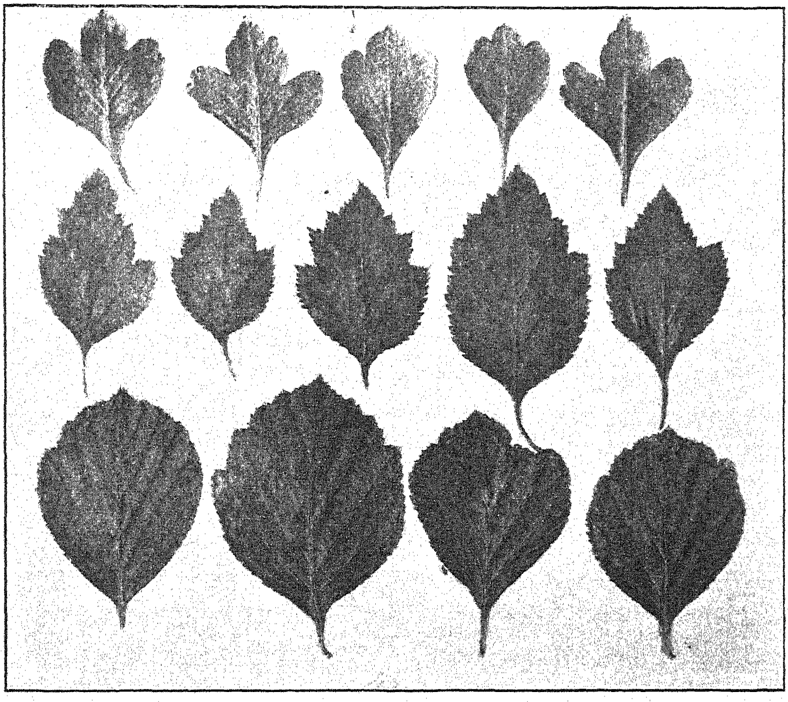

FIGURE 2. Uppermost row, leaves of *Crataegus spathulata;* middle row, *C. Beadlei;* lowest row, *C. collina;* about two thirds natural size.

deep, rich clay soils abundantly supplied with moisture and also in thin dry soils barely covering ledges of rocks. In the former situation it may become a much branched, graceful, showy tree 20 to 25 feet in height. In the latter, it assumes a low, fantastic, broad-headed, gnarled, and irregular habit of growth. In some situations this thorn forms almost impenetrable thickets. In the open, the stiff, tortuous branches sometimes grow in well defined,

horizontal or downward sloping planes. The almost vertically growing leaves are very abundant, smooth above, and rather a dull shade of dark green. These are arranged almost invariably along the upper side of the branches in numerous close clusters which closely invest the compound corymbs of small, white, numerous bossoms. Each flower cluster is made up of from 12 to 25 blossoms. The buds are sometimes rose-tinged. About May 1, the slender branches become graceful, white flower plumes, which fill the air around with a pleasing, penetrating, spicy fragrance. Slender, tapering thorns from 1 to 1.25 inches long are usually abundant. The bark of this *Crataegus* is usually smooth and gray or brownish in color. The tiny fruits are ripened abundantly about October 15 at Thompson's Mills. These fruits are small, globose or somewhat flattened, reddish orange in color, and do not shed readily when mature as with *C. uniflora* and others.

The fruits are dry and possess little taste. This thorn is one of the most ornamental shrubs in the Thompson's Mills region, and deserves far more attention than it usually receives.

CRATAEGUS UNIFLORA Muench. This pretty little *Crataegus* is a very common species in fields and rocky pastures. In the stock pasture mentioned at the beginning of this paper, particularly fine round-headed specimens of this thorn are everywhere common. Here it is a small, much branched shrub usually from two to about four feet in height. Under favorable conditions its short, numerous, stiff branches grow out equally on all sides producing a compact, rounded and symmetrical shrub of very pretty appearance.

The pale green mostly obovate or oblong cuneiform leaves are crenate-toothed and finely pubescent, so that it appears as if the upper surface were covered with the thinnest gossamer.

The almost sessile blossoms, which are about 0.5 inch in diameter, appear about the first week of May and are mostly solitary or in corymbs of two or three. The small size of these blossoms makes them rather inconspicuous among their leaf rosettes, so that they do not greatly add to the ornamental qualities of the shrub during the season of bloom. They possess, however, a very marked spicy fragrance. A conspicuous feature of the blossoms of this thorn is the calyx with its long, narrow, leaflike, sharply

serrate divisions about twice the length of the white petals. The thorns are slender, straight and rigid, running from 1.5 to 1.75 inches in length.

The fruit ripens about the middle of October and at maturity falls with the slightest touch. These fruits are smooth, globose, 0.5 inch or more in diameter, and orange-red in color. The flesh is firm, rather juicy, and with a spicy odor and taste. The prominent calyx adds noticeably to the appearance of the pretty fruits. This little thorn is extremely attractive in autumn when sprinkled with the rather large orange-red haws.

CRATAEGUS COLLINA Chapman. This *Crataegus* is a common species at Thompson's Mills. It is seen at its best in open fields, where it sometimes becomes a much branched, round-headed tree 15 to 18 feet or more in height.

The leaves are somewhat coarse in texture, dark, dull green in color, mostly obovate and doubly serrate. The young twigs are somewhat pubescent. Thorns are numerous, stout, and about 1.5 inches long.

This *Crataegus* blossoms several weeks earlier than the other species mentioned in this paper, all of which are in bloom about May 1. On this date in 1910, some trees of *C. collina* were loaded with haws 0.25 inch or more in diameter, green or slightly tinged with red on one side. At maturity the fruits are large, globose, and red in color. *Crataegus collina* is one of the largest and most ornamental thorns at Thompson's Mills.

CRATAEGUS BEADLEI Ashe. This *Crataegus* is fairly common locally at Thompson's Mills. It is especially common on the wooded pasture hillside mentioned earlier in this paper. Here it is rather evenly distributed as underbrush beneath the heavy pines, and attains a height of from 8 to 10 feet. The branches are somewhat tortuous and irregular in their manner of growth, producing an open-headed, straggling bush.

The leaves are thin, delicate, light green in color, and quickly wilt when a branch is cut. The compact corymbs are from 1 to 1.5 inches across, and include from four to six white showy blossoms. These corymbs are scattered along the slender branches, and rarely include more than five blossoms, which fill the air in the vicinity with a heavy, sweet, pear blossom fragrance. The blossoms are from 0.5 to 0.75 inches in diameter.

The duration of the blossoming period varies considerably in different individuals. Some bushes open their blossoms almost simultaneously. Others blossom more slowly for a considerable interval so that the intermingling of the buds and blossoms pro-

FIGURE 3. *Crataegus Beadlei* Ashe, in bloom.

duces a very pleasing effect. The heavy fragrance of these blossoms attracts great numbers of bees and wasps. The fruit is ripened about the middle of October, and readily falls when ripe. These fruits are oval to globular, somewhat irregular in outline,

and dull orange-red in color. At Thompson's Mills, this *Crataegus* shows considerable variation in size of thorns, blossoms, fruits, etc.

Crataegus Beadlei occurs mainly in woods at Thompson's Mills. This thorn was first described in 1900 by Ashe, who found it at Salisbury, North Carolina.* The Thompson's Mills record of this thorn makes it an addition to the flora of Georgia.

In many respects the species of *Crataegus* are among our

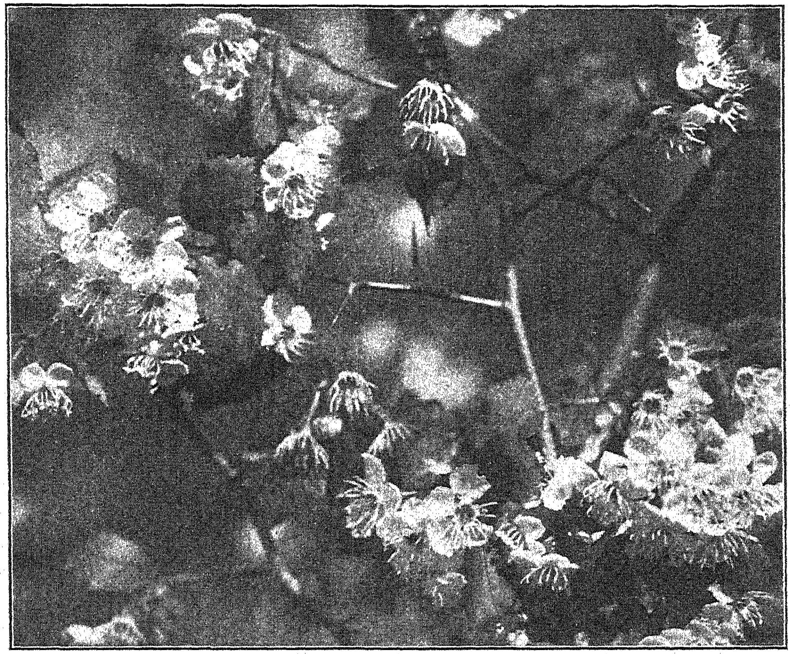

FIGURE 4. *Crataegus Beadlei* Ashe, showing leaves and flowers; somewhat reduced.

hardiest and most ornamental native shrubs and trees, and they deserve to occupy a prominent place in the adornment of all home grounds and parks. These shrubs in most instances become strikingly lovely during the season of bloom. A number of species are worthy of cultivation for their foliage effects alone. In autumn the abundant orange and red haws again render most species very attractive.

* See "New North American plants—Some new species of *Crataegus*" in Bulletin 175 of the North Carolina College of Agriculture and Mechanic Arts, 1900.

At Thompson's Mills on the estate of the J. N. Thompson Co., several fine individuals of *C. collina* have by good foresight been allowed to grow until they have become especially fine, large, flourishing trees.

Crataegus collina is the finest species in this region, and in open, favorable situations it becomes a clean, compact, symmetrical round-headed tree, the heavy foliage of which affords an abundance of shade.

In this region *Crataegus spathulata* has few peers among the wild, native ornamentals. The dark green leaves of *C. Crus-galli*, which are as glossy as if they had been varnished, are an especially attractive feature of this thorn. The smaller *C. Beadlei* is most attractive in springtime when covered with the numerous white blossoms. With a little care the species of *Crataegus* can be readily transplanted, and may be trained to become very graceful and shapely shrubs or trees. It is rather to be deplored that we so often neglect our wild, native ornamental thorns for something foreign and oftentimes not nearly so hardy or so pleasing to the eye.

BUREAU OF PLANT INDUSTRY,
U. S. DEP'T OF AGRICULTURE,
WASHINGTON, D. C.

Panama mosses

R. S. Williams

The following rather brief list of mosses is made up of species collected along the Canal Zone by Dr. Marshall A. Howe, in the latter part of 1909 and early in 1910, and by the author, about a year previously, chiefly in the vicinity of Penonomé, some hundred miles west of the zone, and also about Cana, nearly the same distance east of the zone, in the province of Darien.

Of the 39 species listed, 32 occur in South America, 9 species are found in both North and South America, and 6 species, I believe, are known only from Central America.

Dicranella Hilariana (Mont.) Mitt. *Howe*, Culebra, Dec. 1909.

I believe this to be a widely distributed species occurring throughout northern South America, the West Indies, Mexico, and the southern United States. It includes numerous slight varieties that have been given specific names, among others *D. tenuirostris* (Kunze) Mitt., *D. Liebmanniana* (C. M.) Besch., *D. mexicana* (Besch.) Jaeg. and *D. trematodontifolia* (C. M.) Par.

Dicranella Perrotettii (Mont.) Mitt. *Williams 1058*, Cana, on earth along ditches, April.

Holomitrium crispulum Mart. *Williams 1059*, Cana, on trees at 900 m., April.

Leucobryum giganteum C. M. *Williams 1061*, Cana, at 1200 to 1800 m.

Octoblepharum albidum (L.) Hedw. *Howe*, Taboga Island, and *Williams 1048*, Penonomé.

Fissidens polypodioides (Sw.) Hedw. *Williams 1080*, Cana, 1800 m. alt.

Syrrhopodon brachysteloides C. M. *Williams 1052*, Marraganti, at head of Gulf of San Miguel, on trees at 15 m. elevation, April, 1908.

Syrrhopodon Bernoullii C. M. *Williams 1046*, near Cana, 1200 to 1800 m. elevation, April, 1908.

HYOPHILA OERSTEDIANA C.M. *Howe*, Taboga Island, on rock, Dec. 1909. This determination is from description by C. Mueller in Syn. Musc. 2: 622. The type specimens were from Nicaragua.

MACROMITRIUM APICULATUM Hook. *Howe*, Gatun and Ahorca Lagarto, Jan. 1910.

MACROMITRIUM MUCRONIFOLIUM Hook. & Grev. *Williams 1066*, on trees near Penonomé at 600 m., March, 1908.

Macromitrium flavopilosum sp. nov.

Pseudoautoicous: in rather loose mats with bare or more or less tomentose creeping stems and rather distant, short, robust, often divided branches up to 2 cm. high, with crowded, spreading-flexuous, slightly undulate leaves; upper leaves 8 to 9 mm. long, narrowly lanceolate, smooth on both sides, serrulate on margin in upper half, gradually tapering into a yellowish, nearly straight, smooth hair point, slightly denticulate at apex and from one third to two thirds as long as blade; leaf cells narrow and elongate throughout with thickened walls, in rather straight rows, without furrows between from base to above the middle, in upper leaf scarcely in rows; perichaetial leaves scarcely differing from stem leaves: seta smooth, about 1 cm. high; capsule scarcely 2 mm. long, smooth, oval; lid convex, with slender, straight beak two thirds the length of capsule; peristome double, papillose, reddish brown, the outer a low cylinder with irregular margin, the inner a little higher than the outer with margin more deeply incised; calyptra without hairs, lacerate below, somewhat rough at apex; spores rough, up to 30μ in diameter.

TYPE LOCALITY: Cana, Prov. Darien, Panama. *Williams 1063*.

A species much like *M. ulophyllum* in habit but leaves less undulate above, without a distinct border and median cells not in oblique rows.

PHILONOTIS SPHAERICARPA (Sw.) Brid. *Howe*, Culebra and Taboga Island, Dec. 1909. This is *P. nanodendra* C. M.

BRYUM CORONATUM Schwaegr. *Howe*, Culebra and Taboga Island; and *Williams*, Penonomé, in cultivated fields.

RHIZOGONIUM SPINIFORME (L.) Bruch. *Williams 1047*, Cana, at 1200 to 1800 m.

PSEUDOCRYPHAEA FLAGELLIFERA (Brid.) E. G. Britton. *Williams 1076*, Cana.

LEUCODONIOPSIS PLICATA Ren. & Card. *Williams 1068*, Cana at 650 m.

PRIONODON DENSUS (Sw.) C.M. *Williams 1062*, Cana.

ORTHOSTICHOPSIS TETRAGONA (Sw.) Broth. *Williams 1069*, Cana at 900 to 1200 m. elevation and *1078*, Marraganti, 15 to 30 m. elevation.

LINDIGIA ACICULATA (Tayl.) Jacq. *Williams 1055*, Cana.

METEORIOPSIS RECURVIFOLIA (Hornsch.) Broth. *Williams 1067*, Cana at about 90 m.

METEORIOPSIS PATULA (Sw.) Broth. *Williams 1079*, Marraganti, 15 to 30 m. elevation.

PHYLLOGONIUM FULGENS (Sw.) Brid. *Williams 1044*, Cana, 1200 to 1800 m. alt. A slender form, var. *gracile* Ren. & Card.

PHYLLOGONIUM VISCOSUM (Palis.) Mitt. *Williams 1045*, Cana at 1500 to 1800 m.

NECKERA UNDULATA (Palis.) Hedw. *Williams 1050*, Marraganti, 30 to 60 m. elevation, April, 1908.

NECKERA DISTICHA Hedw. *Williams 1049*, Marraganti, 30 to 60 m. elevation.

POROTRICHUM COBANENSE C.M. *Williams 1053*, Cana, April, 1908.

PILOTRICHUM AMAZONUM Mitt. *Williams 1105*, Marraganti, April, 1908.

These seem to be the only specimens obtained of this species since the type was collected by Spruce on the Amazon.

Stereophyllum Howei sp. nov.

Autoicous: antheridial buds on stem near the fertile flowers, about 0.5 mm. high, the perigonial leaves ovate, more or less acutely pointed and serrulate with costa often faint, enclosing 4 or 5 antheridia without paraphyses; in thin mats with creeping, somewhat branching stems mostly without radicles, about 1 cm. long; stem leaves mostly 1 mm. long and 0.4 mm. wide, much compressed, inequilateral, elongate-ovate or somewhat lingulate, obtusely or sometimes acutely pointed, smooth on both surfaces, serrulate one half their length or more with flat margins except on narrower side in basal part; costa extending to a little above the middle; leaf cells mostly narrowly linear and somewhat vermicular, the median about 4μ wide and 40 to 80μ long, the alar sometimes scarcely differentiated or of pale, rectangular to nearly square cells, mostly not very numerous; perichaetial leaves

ovate-lanceolate, up to 1 mm. long, serrulate often for three fourths their length, faintly costate in lower half: seta 10 to 12 mm. long; capsule oval, scarcely 1 mm. long, the lid highly conical with short beak rather over one half capsule in length: annulus evidently wanting; outer teeth of peristome with highly projecting lamellae on inner side above the middle, the inner peristome a little shorter than outer, punctate, with lanceolate, keeled, solid segments and stout, solitary cilia; spores smooth, about 16μ in diameter.

TYPE LOCALITY: Taboga Island, Panama Bay.

Collected on a shaded rock by M. A. Howe, Dec. 13, 1909.

This species evidently belongs to the group under G of section 2 of the genus as given by Brotherus in the Engler & Prantl, Natürliche Pflanzenfamilien.

CYCLODICTYON LIEBMANNI Schpr. *Williams 1070 and 1075*, Cana, 1200 to 1800 m., April, 1908.

CALLICOSTELLA PALLIDA (C. M.) Jaeg. *Williams 1064*, Cana, 1200 to 1800 m.

LEPIDOPILUM BREVIPES Mitt. *Williams 1057*, Cana, on trees at 900 m., in fine fruit, April 20, 1908. This seems to be the only other collection of this species since the type was collected by Spruce on the Amazon at about the same altitude.

LEPIDOPILUM POLYTRICHOIDES (Hedw.) Brid. *Williams 1056*, Cana at 200 m., in fine fruit, April 20, 1908. Growing in spray of waterfall.

LEPIDOPILUM SEMILAEVE Mitt. *Williams 1054*, Cana, on trees at 1200 to 1500 m. alt.; collected also above Penonomé, *1065*, on branches; in fine fruit, March and April, 1908.

HYPOPTERYGIUM TAMARISCI (Sw.) Brid. *Williams 1053*, Cana, at 1800 m.

TAXITHELIUM PLANUM (Brid.) Mitt. *Howe*, Gatun and Mt. Hope, Jan. 1910.

TRICHOSTELIUM FLUVIALE (Mitt.) Jaeg. *Howe*, Mt. Hope.

SEMATOPHYLLUM PUNGENS (Sw.) Mitt. *Williams 1071*, above Penonomé at about 600 m. ele., and *1072*, Cana at 1200 to 1800 m.

RHYNCHOSTEGIUM SCARIOSUM (Tayl.) Jaeg. *Williams 1074*, Cana, on bark at 1200 to 1800 m.

NEW YORK BOTANICAL GARDEN,
BRONX PARK, NEW YORK CITY

INDEX TO AMERICAN BOTANICAL LITERATURE

(1910)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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EIGHT CUT-LEAVED SPECIES OF VIOLA, 1–4, palmate; 5–8, pedate.

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Flora of Lehigh County, Pennsylvania—I

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INTRODUCTION

In recent years, the phase of botany having to do with plant distribution in all its relations has had such generous attention that while formerly local lists were received with a certain degree of tolerance, now they are not only sought for but desired. Botanical literature is full of treatments of the larger areas, and generous acknowledgment to local floras is the usual rule. In this paper and what is expected to follow later under the same head, the writer desires to record for the benefit of those who can use them certain observations with regard to the flora of that portion of his working field with which he is most intimate.

Lehigh County is one of a group of counties in Pennsylvania which share the Kittatinny Mountains as a boundary. The northern boundary of the county follows the crest of this range westward for a distance of sixteen miles to corner with Berks. The western boundary is a straight line of twenty-nine miles extending south by east and is shared in common with Berks and Montgomery. On the south is Bucks County. On the east, Lehigh County shares with Northampton the Lehigh River as far as Catasauqua. The Second Geological Survey of Pennsylvania (1:D 3) well characterizes the county as "a nearly rectangular figure leaning northwest." It includes an area of three hundred and sixty-four square miles.

The Kittatinny Range, also known as the Blue Mountains,

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is a part of the Appalachian chain and in the county trends to the southwest from Lehigh Water Gap, with an even crest at an altitude of about 450 m., broken only by a few depressions and one noteworthy prominence, Bake-oven Knob, 473 m. The Shawangunk* sandstone and conglomerate of which this range consists belongs to the Lower Silurian Period of the Paleozoic Era. Only the south slope of the range is included within the county. Unlike the north slope, which is long, the south slope is short and steep, from a comparatively sharp and narrow crest, and almost uniformly rocky. A plateaulike shelf, composed largely of fallen talus from the mountain and resting on the underlying shale formation, leads gently away from this steep slope. Many small streams rise here, and there are occasional areas that are marshy or boglike in character, but usually of very limited extent. In the vicinity of the Bake-oven, there arise Trout Creek draining into the Lehigh at Slatington, the Jordan Creek draining into the Lehigh at Allentown, and the Antelawny draining into the Schuylkill in Berks County.

Approximately twenty miles to the south are the South Mountains, or Durham and Reading hills, usually known locally as the Lehigh Mountains. This is a range of gentle slopes and rounded knobs with shallow intervening valleys quite unlike the long sharp-crested and rocky mountains to the north. In general within the county the north slopes are rather longer than the steeper south slopes, but small streams heading in the moist areas of marshy or boglike character in the shallow valleylike depressions between the ridges of the crests are found on both slopes. With the exception of some of the knobs, the average altitude is about 275 m. In New Jersey the region corresponding to this geological formation, which is topographical as well, is called the Highlands and from Pennsylvania southward forms a part of the so-called Piedmont Plateau.

In the vicinity of these hills are outcrops of the Hardyston quartzite and sandstone of the Cambrian Period, which overlies the Pre-Cambrian rocks of which these hills are largely made up.

* These rocks have been known as the Oneida and Medina sandstones and conglomerates but Dr. Benjamin L. Miller, of Lehigh University, has recently referred them to the Shawangunk and this later term is here used through his courtesy.

Still farther south, approximately five miles, are the foothills of the South Mountain range, really a part of the main range which has here spread out to include the considerable area of the Saucon Valley. These hills are practically a continuation of that part of the South Mountain range which in Bucks County is known as the Durham Hills. To the southwest in the county these hills are more closely grouped and in this formation trend southwest into Berks County as far as the vicinity of Reading. In Cumberland County, where this range practically reappears and is properly called the South Mountains, it is a portion of the southern boundary of the Great or Kittatinny Valley.

The greater part of the surface area of Lehigh County lies between these ranges in the Great or Kittatinny Valley. This long and broad valley, like the Kittatinny Range which it parallels, is an important geological as well as topographical feature in the East. The geological formations are of the Cambrian and Ordovician periods of the Paleozic Era, and although they may be subdivided into various minor formations, fall naturally into two well marked divisions, lithologically as well as topographically, which may be characterized as the "slate" or "shale" and the "limestone" regions. The shale occupies the greater surface area and overlies the limestone, which in turn overlies the Hardyston sandstone and quartzite that outcrops in the vicinity of the South Mountains and occupies relatively little surface area.

This shale region differs very materially from the limestone region to the south. Its water courses greatly exceed those of the limestone region numerically, and by the mechanical cutting down of the hills have created numerous wide ravines with sharp rises to the uplands, creating a characteristic topography differing greatly from that of the limestone region to the south.

As the shale region is approached the line of contact with the limestone plain is apparent in the landscape. Within the county this line is irregular on account of shale ridges that extend into the limestone region and widen the shale region westward as they join that formation in that direction. For this reason the shale region along the Lehigh River is about eight miles wide, but at the Berks County line it is twelve and one-half miles wide. Just south of the Kittatinny Range are high hills of approximately

240 m. or occasionally higher, increasing in altitude westward beyond the Jordan Creek, where in Lynn Township they receive the name of Shochary Ridge, and culminating in the Spitzberg, 330 m. The effect of these ridges on the drainage of the northwest portion of the county is marked. Still farther westward beyond the county these ridges rise as high as the Kittatinny Range. In general the entire topography of this formation is characterized by a multitude of short valleys and rounded hills, which range in altitude from less than 180 m. to the maximum above quoted. The average altitude of this "plain," which it really is, must be approximated from these elevations but can be stated at about 210 m.

The limestone region in general is about 60m. lower than the shale region and is characterized by broad river valleys and more gentle rises from the streams to the comparatively even uplands. The resulting topography is like a gentle plain in appearance when viewed from the South Mountains and differs markedly from the rugged shale plain to the north. In the vicinity of the streams outcrops and rocky talus slopes are present. The soil is characterized by greater fertility than the colder, moister soil of the shale region and for this reason the region is largely under cultivation.

The Saucon Valley between the hills of the South Mountain range is almost exclusively of limestone formation with a bit of shale, originally continuous with the formations of the Kittatinny Valley, and is little varied in topography, a lovely valley of mostly cultivated land framed by the hills of the South Mountain range.

On the south the county barely touches the "red sandstone, shale, conglomerate and trap" rocks of the Triassic Period of the Mesozoic Era.

The Lehigh River is the largest stream of the county. From Lehigh Water Gap to Allentown, where it is deflected eastward by a spur of the South Mountain, it flows through the shale and limestone country, and a number of clifflike outcrops and sharp rises of talus slope exist as the result of its erosion.

Several creeks, including Trout Creek, Rockdale Creek, Fells Creek, Spring Creek, and Coplay Creek, drain into it between these points, but about five-sixths of the drainage of the county is directed toward Allentown, where the combined Jordan Creek and Little Lehigh River discharge into the Lehigh.

The Jordan Creek has its rise at the base of the Bake-oven in the Kittatinny Range and has numerous branches within the shale region. In the limestone region, which it enters somewhere in the general vicinity of Guthsville, being deflected eastward here by the Huckleberry Ridge, a shale ridge, the Jordan Creek has practically no branches. Its valley from Guthsville northward is of great beauty, the tortuous windings of the river bed giving rise to ever changing vistas. The sharp rises are frequently clothed with hemlock and pine, sometimes in almost pure stands, and are usually beset with low clifflike outcrops along the water's edge as well as higher up the slopes. In the limestone region the stream is dry as far as Helfrich's Springs for a part of the year.

The Little Lehigh River rises in the South Mountains in Berks County and flows entirely within the limestone region within the county. With the exception of Trout Creek (the second of that name in the county), which empties the drainage of a part of the north slopes of the South Mountains into the combined Jordan-Little Lehigh at Allentown, all the drainage of the north slope of the main range of these hills within the county reaches this stream by its several tributaries. It is fed by numerous springs and some streamlets, having their sources in the limestone as well as the shale region, and has a strong and constant flow even in seasons of drought. Conifers are practically absent from the gentler wooded slopes of the valley of this stream, which lack the wilder aspect of the valley of the Jordan in the shale region.

These streams, together with the Saucon Creek draining the Saucon Valley into the Lehigh River in Northampton County, the Antelawny Creek already mentioned, and some streams reaching over the border into the county on the south, constitute practically all of the streams of importance in the county.

Many water courses of the shale region in general are dry in summer and there are comparatively few permanent moist areas of marshy or boggy character of any extent excepting along its contact with the formations of the Kittatinny Range. Along this range are many such areas, however. The limestone region in respect to such areas resembles the shale. On and in the vicinity of the South Mountains are a number of moist areas of boggy character, usually wooded or shaded by low growth such as alders.

A large proportion of the area of the county is given over to agriculture but there is a large percentage of woodland in the vicinity of the mountains. On the South Mountains the wood is cut at intervals but the new growth seems to develop quickly enough to hold the soil cover well and to restore original conditions with maturing growth. The forest cover of the mostly denuded slopes of the Kittatinny Range is usually rather thin excepting on the shelflike plateau along its base, which however is also frequently denuded, like all our eastern wood cover. Between the mountains the greater proportion of woodland is along the slopes of the streams but there are frequent scattered areas of woodland, especially in the shale region, increasing northward toward the mountains. The forest cover of the South Mountains and southward is practically purely deciduous in character, but northward conifers begin to appear in the limestone region, increasing northward, and at places in the shale region and in the vicinity of the Kittatinny Range equal and perhaps outnumber the deciduous trees.

As far as its flora is concerned, Lehigh County with reference to its zonal position must be included entirely within the Alleghanian area of the Transition.

In Bucks County, just south of Lehigh, and in the counties thence westward there occur areas where typical Carolinian species occur in association. These areas trend rather definitely eastward and westward, roughly parallelling the mountains, and mark the extension northward in that direction of typical Carolinian association. There are no such areas within Lehigh County.

As to its position with reference to the larger rivers of the region, the Delaware, the Schuylkill, and the Susquehanna, which partly flow within Carolinian territory and aid in the extension of Carolinian flora toward the mountains, Lehigh County lies between the Delaware and the Schuylkill. The Lehigh River is a large river but it is deflected eastward by the South Mountains to enter the Delaware without passing south of these hills. Its source is in Lehigh Pond in the "Poconos" of Wayne County, an area rich in species of normal Canadian association. Some of the species found in normal association in the mountains occur in the county along this stream.

Glaciation, which has had such a marked effect on the flora of the corresponding region eastward, principally in New Jersey, is absent from the county. The extensive boggy areas characteristic of that region are not represented and many of the northern species found in association in these areas do not occur here.

The terminal moraine, where it crosses the Delaware River near Belvidere, New Jersey, and the Kittatinny Mountains a few miles west of Delaware Water Gap, is only about twenty miles distant from the county, and the proximity of the great ice sheet of the last glacial invasion must have had its influence on the flora of the county, or at least that portion lying within the Great Valley.

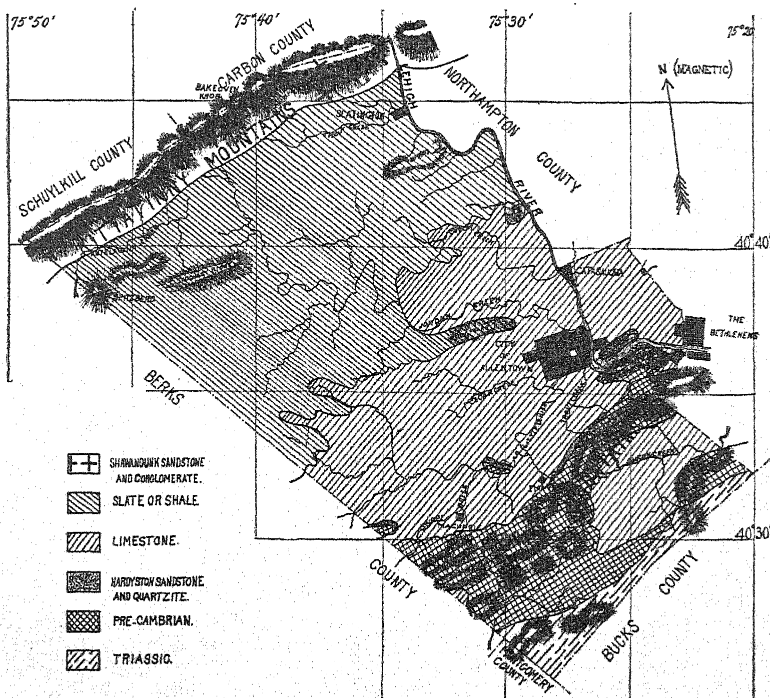
It would appear to a certain extent from its position that Lehigh County is so placed as to include within its boundaries many normally "southern" and "northern" plants. It is true that on account of these extensions the flora of the county is rich and that some species apparently have their limit of extension within the county, but it is doubtful whether Lehigh County equals in number of species any of the counties that bound it, with the possible exception of those to the north. This is an inference due to a review of some of the factors influencing the flora of this region, which have been briefly sketched. Thus, Berks, Montgomery, Bucks, and Northampton counties include within their boundaries many of the species of typical association in the mountains to the northwest, principally along the Delaware and Schuylkill rivers. All of these counties excepting Northampton are rich in extensions of Carolinian flora, which extends well up the river valleys. Northampton County shares with Lehigh the Lehigh River, and in addition its flora is enriched by the addition of a number of species associated with the glaciated region, besides such species as find their way into that county along the Delaware River. Whether the position of Lehigh County is unique with reference to the flora of the region when compared with these bounding counties will best be proven by future records. It has seemed sufficient to the writer to merely indicate such a possibility.

Lehigh County is probably represented in the older collections, but it might prove difficult to confirm some of the older records

because Lehigh County was erected from Northampton on March 6, 1812, and enlarged in 1852 and 1859. A collection made by C. F. Beitel (approximately 1830–1865) is a part of the herbarium at Muhlenberg College, but it gives no dates or localities, though presumably partly collected in this region. There is a record of Elias Durand (1794–1873), the Philadelphia botanist, having botanized along the Lehigh River in the county. Among the Moravians there have always been some persons who were interested in botany. Among those who have visited the county in their collecting may be mentioned Rev. Lewis David de Schweinitz in the fungi, F. A. Wolle in fresh water algae, and Eugene A. Rau in the bryophytes. Mr. Rau's collections in the county have however not been confined to the bryophytes but include interesting records in the pteridophytes and spermatophytes. Dr. A. L. Huebener, of the Moravian Seminary, also collected in the region. His collection is a part of the Seminary herbarium. Prof. T. C. Porter also visited the county, though his list shows few records for the county. Dr. A. F. K. Krout, of Glenolden, Pa., resided in the Borough of Coplay in the county from 1869 to 1892 and refers to Capt. P. A. Lantz, of Saegersville, in the county as a coworker at the time. Dr. Krout collected actively during his residence in the county, and his collection, including some from the collection of Capt. Lantz, is now a part of the herbarium of the Philadelphia Botanical Club at the Academy of Natural Sciences at Philadelphia. Until his death several years ago, Dr. William Herbst, of Trexlertown, collected chiefly in the fungi. For severa years, during Dr. Philip Dowell's connection with Muhlenberg College, a large part of his leisure was given to collecting in the county. The writer acknowledges with pleasure his great indebtedness for his knowledge of field botany, especially in the pteridophytes, to Dr. Dowell, with whom he was usually associated on these excursions. Mr. D. W. Hamm, a student at that time and now a teacher, also an associate in field excursions, has retained his interest in the study. Mr. C. N. Lochman, who is associated in business with Mr. E. A. Rau in Bethlehem, is an active field worker who has frequently botanized within the county. Mr. C. C. Bachman is an active field botanist and has collected considerably in the county. Other botanists of adjoining counties

have botanized within the county, and several visits by members of the Philadelphia Botanical Club have been made. The following residents of the county are likewise interested in our flora: Rev. Dr. J. A. Bauman, Messrs. M. S. Hartung and H. D. Bailey, and Rev. W. N. Kopenhaver.

In the following list, unless otherwise indicated, in every case where a station has been named, its exact distance is given in a carefully approximated direction from some name on the Topographical Maps of the U. S. Geological Survey, which cover all but a small portion of the county. The actual bog, streamlet, etc., may not appear on these maps but exists nevertheless and the above method is intended to standardize these citations and make the use of local terms subordinate. Distance from the City of Allentown has been given from the Center Square.



Map of Lehigh County, Pennsylvania.

PTERIDOPHYTA

In the following list the writer has attempted to present, with particular reference to Lehigh County pteridophytes, some observations that may be of more general interest. For the sake of brevity these observations have been reduced to a minimum. Stations have been mentioned for some of the rare or less frequent species and an attempt has been made to have the original discoverers of such stations receive the credit that is due them. In this connection it has not been thought necessary to mention more than the original collection from a station.

Material from practically all of the stations mentioned is in the herbarium of the writer as well as, in part at least, in that of other collectors. The inclusion of all the data would only increase the list unnecessarily. The exact measurements given are from herbarium material almost exclusively. They are used merely as a guide in connection with average or luxuriant growth. The figures in parenthesis following the length of leaf indicate length of stipe + length of blade. Herbaceous and evergreen are not to be taken too literally but serve to indicate comparative hardiness of the species. It is well known that sterile fronds in general outlast the fertile and it has not been thought necessary to indicate in every case the part protection plays in the apparent hardiness of a species. Seasons vary too with the years.

In general the pteridophytes of the county follow in relative frequency and abundance certain broad lines due to the distribution of habitats favorable to their growth. The term "the South Mountains" used in this connection is general and includes all of the hills of this range but refers particularly to the main ridge of these hills, about three miles southward from Allentown, called Lehigh Mountain, On some of the spurs and outlying hills of this range some species, like the spinulose wood ferns, become relatively less abundant, especially to the south within the county.

ADIANTUM PEDATUM L.

General in moist situations, growing on all formations and soils, but most abundant in boggy areas and along streams on the South

NOTE: Where the collector's name is not given the specimens were collected by the writer.

Mountains. Rather frequent in moist situations on the talus slopes and at the bases of outcrops along the streams. On the wet "shale" formations along the Lehigh River, fronds 3.4 dm. long by 4.1 dm. wide with stipe 4.1 dm. long have been collected. This represents maximum luxuriance, the fronds in general being less luxuriant. Fruits late July and August. Herbaceous. withering early, but has been found in protected situations still green in November.

ANCHISTEA VIRGINICA (L.) Presl

Collected at a single locality along the Kittatinny Mountains north to west of Slatedale, August 9, 1909, *2104*.

It occupies an area of 20 feet in circumference, in practically pure association, in a low shallow depression filled with water for a part of the year but dry in summer. Also in somewhat similar habitat just south of this station along the public road running parallel to the mountain (October 10, 1909, *2285*), an area of rather limited extent, marshy for a part of the year but later drier, with sphagnum beds, etc., a duplicate of similar places along the range. It has not been found fruiting abundantly, a condition probably not normal as the writer has collected it near Saylorsburg in Monroe County, Pa., on July 25, heavily fruited and in abundance. Fronds 9.8 dm. (3.7 + 6.1) long and 2.6 dm. wide represent rather below average luxuriance. Herbaceous.

The frequent occurrence of this species in abundance along the coast and in association with Carolinian flora farther inland is to be expected, but still farther inland, especially in the mountainous region away from typical Carolinian association, its occurrence is always of interest.

ASPLENIUM EBENOIDES R. R. Scott

Lehigh County, in Porter's list. Helfrich's Springs, 1⅞ miles northwest by north of Allentown, 1901, *Hartung*. Along the Little Lehigh, 1½ miles southwest of Allentown, July 16, 1901, *Hamm;* December 8, 1907, *1063*. 2 miles southwest of Allentown, August 3, 1901, *97*. Along the Jordan, ½ mile west of Jordan Bridge, September 2, 1907, *856*. Along the Lehigh River, ½ mile below Ferndale, August 21, 1908, *1484*. Along Cedar

Creek in Dorney's Park, March 19, 1910, *2324*. Along the Jordan, 1¾ miles northwest of Kernsville, November 6, 1910, *3101*. Along the Little Lehigh, 1⅜ miles northwest of Emaus, December 22, 1907; November 24, 1910, *3137*.

All occur on limestone with the exception of *3101*, which was collected on shale.

As far as the writer has been able to ascertain, no less than 25 specimens of this fern have been collected in the county. The reader scarcely needs to be reminded of the abundance of the putative parent species of this hybrid in association in the county. These specimens have come from 7 stations, a station being defined for the purposes of this statement as some isolated area, wooded or not, separated by cultivated land from an adjacent station. Thus plants were taken at Helfrich's Springs at two places about one-third mile apart. No station as conceived by the writer is nearer to any other station than one-half mile. Of 6 plants left in the field, not included with the 25, 3 are known to have disappeared. All but 6 of the specimens noted are or have been a part of the writer's herbarium and represent all of the stations. Credit for finding a number of these is due to E. S. and W. Mattern, who have frequently been the writer's field companions. Some observations of interest with reference to this species have been made by the writer but would prove too lengthy for the purposes of this list.

ASPLENIUM MONTANUM Willd.

On rocks of Hardyston sandstone, southwest of Mountainville, on the South Mountains, Idlewild, 1872, *Krout;* January 25, 1908, *1073*. On "shale" along the Jordan Creek, 1¼ miles west to northwest of Kernsville, November 6, 1910, *3095*.

In fair abundance at both stations. Growing well shaded at both stations but less luxuriant at the first named than at the second, where fronds 17 cm. (8+9) long and 4.5 cm. wide have been collected and represent maximum luxuriance. Can be collected in July with old fronds still in good condition and new fronds starting to fruit but is in best condition in late fall. Evergreen.

The recorded stations for this species in New Jersey and Pennsylvania, limiting the southwest extension of the species from the mountains, are Delaware Water Gap in New Jersey, and in Penn-

sylvania, Easton, Northampton County, Lehigh County on the South Mountains, Chester, Lancaster, and York counties. Along the Lehigh River in Carbon County there are a number of stations.

ASPLENIUM RUTA-MURARIA L.

Near Helfrich's Springs, 2⅛ miles north by northwest of Allentown, 1882, *Krout*. Along the Little Lehigh, foot of 17th Street, Allentown, October 2, 1900, *Hamm*. 1¾ miles southwest of Allentown, October 21, 1900, *Dowell 1036*. 2⅛ miles southwest of Allentown, August 3, 1901. 1⅛ miles west by northwest of Emaus, December 22, 1907, *1064*. Along the Jordan, ⅜ mile east of Jordan Bridge, October 30, 1910, *3062*. Along the Little Lehigh, 1⅛ miles northwest of Emaus, November 24, 1910, *3140*. Near Salsburg Church, ⅜ mile north of the last, *3142*.

Occurs only on limestone in the valleys of Jordan Creek and the Little Lehigh, where it may be expected throughout. Not usually abundant excepting in the woods near Salsburg Church and at Helfrich's Springs, where quarrying has done much injury to the station. In shaded and exposed situations. Fruiting fronds 10 cm. (6+4) long and 3 cm. wide represent maximum luxuriance but fruiting fronds 2 cm. long have been collected. Fruits in July, but is at its best in fall. Evergreen well through the winter, especially the sterile fronds. The species varies in the shape and cutting of the pinnules or ultimate segments, from narrow and lacerate to broad or round-wedgeshaped and merely crenate or toothed. Apparently this species is to be expected on limestone in eastern Pennsylvania and on corresponding formations in northern New Jersey.

ASPLENIUM PLATYNEURON (L.) Oakes

General throughout, on all soils and formations and in all situations excepting wet ground. Frequently lining roadsides and railroad embankments in abundance but no less frequent and abundant in varying situations elsewhere. Sometimes growing in the clefts of rocky outcrops. Specimens with fronds 5.1 dm. (0.6+4.5) long and 3 cm. wide represent a fair average for luxuriant plants. Collected in fruit on June 26. Sterile and fertile fronds lasting well through winter but usually prostrate in November.

The writer knows of no species that is more evenly distributed in the county. On limestone and especially shale it tends to become serrate, and forms with not only some of the pinnae of the fertile frond serrate but the sterile also, are not rare. (On "shale" along Jordan Creek 1⅛ miles northwest of Kernsville, November 6, 1910, *3096*.)

Mr. E. S. Mattern found a plant on Hardyston sandstone along the Little Lehigh River, 1¾ miles west by northwest of Emaus, near Salsburg Church, which corresponds to the named variety *Hortonae*.* This plant grew true for two seasons and when collected (July 17, 1908, *1351*) had three fronds of fertile form fully expanded, averaging 2.4 dm. (0.4+2) long and 3 cm. wide, but quite sterile, a correlated character of the variety as originally described.

ASPLENIUM TRICHOMANES L.

General on shale and limestone outcrops, not infrequently locally abundant. Has been recorded sparingly by the writer on Hardyston sandstone on the South Mountains 1¼ miles (March 28, 1908) and 1 mile (October 16, 1909, *2299*) southwest of Mountainville, and on Shawangunk sandstone at Lehigh Gap (January 19, 1908, *1069*). Fronds 19 cm. (3+16) long and 1.2 cm. wide represent maximum luxuriance, as do rosettes 17 cm. in diameter. Fruits in July. Evergreen.

In the county the species is "common" on the shale and limestone but rare on other formations. In the mountains to the north in the vicinity of the Lehigh River, the writer has found the species very infrequent.

ATHYRIUM ACROSTICHOIDES (Sw.) Diels

Frequent and abundant in boggy places and along streams on the South Mountains. Occurs on shale ⅛ mile south of Saegersville (July 7, 1907, *586*), along the creek ⅝ mile east of Hoffman (May 16, 1909), and at the base of the cliffs along the Lehigh River above Rockdale (May 16, 1909). Also in Lower Milford Township, 1⅜ miles southwest of Locust Valley, in the vicinity of a branch of East Swamp Creek (July 17, 1910, *2666*). It may be expected throughout. Fronds 9.8 dm. (3.5+6.3) long and 2.1 dm. wide represent average luxuriance. Heavily fruited in shade by August 6 but has been collected in fruit as early as July 13. Herbaceous.

**Asplenium ebeneum Hortonae* Dav. Rhodora 3: 1. *pl.* 22. 2 Ja 1901.

ATHYRIUM FILIX-FEMINA (L.) Roth

General throughout, on all soils and formations. Most abundant in the bogs and along streams on the South Mountains. Fronds 9 dm. (3.6+5.4) long and 2.8 dm. wide represent average luxuriance in one form of the species. It has been collected with mature fruit on July 2. Herbaceous. The variability of this species is well known.

BOTRYCHIUM DISSECTUM Spreng.

Not infrequent throughout, but most general and abundant on the South Mountains. Plants with fronds 10.5 cm. long and 18 cm. wide and standing 4.5 dm. high to top of fertile frond represent maximum luxuriance. One plant in fruit with blade 1.5 cm. long and 2.5 cm. wide standing 9.5 cm. high has been collected. Collected in fruit on August 25. Fertile fronds have been found still erect in November but are generally prostrate and withering at that time. Sterile fronds turning bronze red and lasting through the winter.

BOTRYCHIUM LANCEOLATUM (S. G. Gmel.) Ångs.

Vicinity of bog 1 mile south by southwest of Mountainville, September 25, 1909, *2248*. Back of Gruver's, along the third streamlet, 1⅜ miles east by northeast of Mountainville, September 25, 1910, *2984*. Above Idlewild, along streamlet at Mountainville, October 8, 1910, *3008*.

Collected only at these stations on the South Mountains. Only eight plants have been seen, the largest standing 16 cm. high. Attention is directed to the dates when the spores were in good condition as well as the comparative rarity of the plants. *B. neglectum* on these dates had entirely disappeared from the stations where it was earlier abundant.

All stations for this species are from counties in the mountains to the north and northwest, excepting the above and a record published in Torreya * by W. H. Leibelsperger for Fleetwood, Berks County.

BOTRYCHIUM NEGLECTUM Wood.

Second streamlet one mile east northeast of Mountainville, May 30, 1907, *D. W. Hamm;* same place and date, *349*. First streamlet 1 mile southwest of Mountainville, June 8, 1908, *1233*.

* Torreya 7: 215. 19 N 1907.

Vicinity of spring near Waldheim, ½ mile southwest of Mountainville, June 13, 1908, *1248*. Vicinity of bog 1 mile south by southwest of Mountainville, June 14, 1908, *1259*. Second streamlet 1¾ miles southwest of Mountainville, June 28, 1908, *1302*. Abandoned ore pits west of above station, May 29, 1909, *1857a*. Near Gruver's, along third streamlet, 1⅜ miles east by northeast of Mountainville, June 15, 1910, *2545a*.

All of the stations are on the South Mountains. Inclined to abundance at the third, fourth, and sixth stations. A plant standing 2.7 dm. high has been collected and represents maximum luxuriance, though plants approaching these figures are not infrequent. A plant with the sterile segment 7.5 by 8 cm. has been collected and is closely approached by other plants in the writer's herbarium. Plants 8 cm. high with clearly defined characters have been collected. Has been found well out of the ground but not unfolded on April 11 and has practically disappeared late in July. Collected with ripe fruit on May 29. Variable with very suggestive forms.

BOTRYCHIUM OBLIQUUM Muhl.

The same remarks used in connection with *B. dissectum* apply also to this species. Specimens have been collected that exceed the measurements given under that species.

Both this and *B. dissectum* are very variable and forms suggesting intermediates have been collected. Sometimes varying in abundance locally, the habitats of both species appear identical, though certain forms of *B. obliquum* are apparently associated with the wet shaded bogs.

BOTRYCHIUM SIMPLEX E. Hitchcock

Near Gruver's, along third streamlet, 1⅜ miles east by northeast of Mountainville, June 15, 1910, *2545b*.

Plants collected at the above station have been referred to this species. Some doubtful material from another station, which may belong here, has been withheld. R. C. Benedict in a recent revision of the Botrychiums observes that they constitute "a complex group" and that "the question of specific limits is by no means settled." An active interest in the observations on this group has apparently developed, which will undoubtedly lead to

a better understanding of the group and very probably affect a revision of this list materially.

BOTRYCHIUM TENEBROSUM A. A. Eaton

Along streamlet above Mountainville, July 4, 1900, *Dowell 830*.
Along second streamlet 1¾ miles southwest of Mountainville, July 13, 1907, *604*. Both stations are on the South Mountains. Edge of a bog, on a spur of the South Mountains along the Lehigh River, 1¼ miles northwest of Strassburg (S.E. Allentown), July 4, 1908, *1315*.

Practically absent from the original station detected by Dr. Dowell but still occurring sparingly at the stations later detected by the writer. It has been collected in good condition as early as June 6 and as late as July 24. At this time *B. neglectum* was withering or had disappeared. The third station was visited again on May 28 of this year [1910] and several plants were found coming up. Plants ranging from 4.5 cm. to 18 cm. in height have been collected. One plant with some portions of the sterile segment fruiting has been collected.

BOTRYCHIUM VIRGINIANUM (L.) Sw.

General throughout, on all soils and formations. Frequently abundant. The writer has a record of a plant standing 8 dm. high from ground to top of the erect sporophyl. This represents above maximum luxuriance, the plants in luxuriance being usually somewhat lower. Collected as early as May 30 but is mature in the middle of June. Herbaceous, the sterile segment lasting well into fall.

CAMPTOSORUS RHIZOPHYLLUS (L.) Link

On gneissic rocks, on a spur of the South Mountains, ⅞ mile northeast of Strassburg (S. E. Allentown), September 7, 1907, *898*. On gneissic rocks, Big Rock, 1 mile southeast of Mountainville, October 12, 1907, *1032*. On Hardyston sandstone, 1½ miles southwest of Mountainville, May 9, 1908. On gneissic rocks, Idlewild, Mountainville, 1909, *E. S. Mattern*. On gneissic rocks, Powder Valley, August 28, 1910, *2892*. On gneissic rocks, 1 mile southwest of Macungie, November 13, 1910, *3119*.

All of the above stations are on the South Mountain range.

Rare at the stations named above but so general and often so abundant on shale, and especially limestone, that any mention of stations on these formations would be useless. The species may occupy niches or grow in large patches on outcrops but is equally at home on loose talus in shade or in the open. It has not been found growing among moss on tree trunks, but with moss on some outcrops it suggests strongly epiphytic tendencies. Most luxuriant and freely proliferous in connection with moist, mossy situations on large talus or sometimes on outcrops. Fronds 4.2 dm. (1.1+3.1) long and 2.5 dm. wide represent maximum luxuriance. Fruits in August. Evergreen.

On limestone and shale the tendency to prominent auricles and undulate margins is very pronounced. Fronds very much incised have been collected. (On limestone, 1⅜ miles northwest of Emaus, January 1, 1908, *1068*.) Forking fronds with both tips proliferous have been collected. (On shale, ⅜ mile east of Jordan Bridge, October 30, 1910, *3065;* 1⅛ miles northwest of Kernsville, November 6, 1910, *3067*.) Also fronds with auricles lengthened and proliferous. (On limestone, 1⅝ miles north by northwest of Emaus, December 22, 1907, *1065;* on shale, ½ mile northwest of Kernsville, November 6, 1910, *3088*.)

CHEILANTHES LANOSA (Michx.) Watt

In fair abundance ½ mile northwest of Kernsville on an outcrop of shale along the Jordan facing south; May 9, 1909, *1765*. Fronds 2.3 dm. (0.9+1.4) long and 3.5 cm. wide represent average luxuriance. Fruits July. Evergreen, lasting well through the winter.

Apparently this is not a rare species in the counties to the south of Lehigh but this is one of the stations limiting the extension of the species toward the mountains.

DENNSTAEDTIA PUNCTILOBULA (Michx.) Moore

General throughout, a frequent species of roadsides and edges of woodlands, clearings, etc. In the mountains frequently abundant in open sunny places in the woods. Sometimes growing from niches or crevices on outcrops. Fronds measuring 8.3 dm. (1.8+6.5) long and 2.1 dm. wide represent maximum luxuriance. Collected in mature fruit on July 12. Herbaceous, but has been found still green in November.

DRYOPTERIS BOOTTII (Tuckerm.) Underw.
D. cristata × *intermedia* Dowell

One-fourth mile south of Saegersville, July 7, 1907, *535*. In bog and along streamlet 1⅞ miles southwest of Mountainville, August 3, 1907, *704*. Near Waldheim, ½ mile southwest of Mountainville, October 16, 1909, *2287*. General vicinity of bog 1 mile south by southwest of Mountainville, November 12, 1910, *3107*. Along streamlet ⅜ mile east of Shimersville, November 13, 1910. *3128*. Vicinity of streamlet 1⅜ miles southeast of Emaus, November 13, 1910, *3134*.

Approaching anything like abundance in only a limited boggy area near Saegersville, the only station noted in the county outside of the vicinity of the South Mountains. Not rare, neither inclined to abundance at the other stations, which would indicate that this species is to be expected in bogs on the South Mountains and elsewhere in association with the other related members of the *Dryopteris* group. Fronds 9.1 dm. (2.7+6.4) long and 1.5 dm. wide represent maximum luxuriance. Collected with ripe fruit on June 28. Sterile fronds evergreen, the fertile lasting well into winter. Variable.

DRYOPTERIS CRISTATA (L.) A. Gray

Lehigh Mountain along Lehigh River, 2 miles southwest of Bethlehem, September 1878, *E. A. Rau*. Streamlet above Mountainville, August 8, 1900, *Dowell 903*. Third streamlet 1⅜ miles east northeast of Mountainville, September 15, 1900, *Hamm*. Bog ⅛ mile south of Saegersville, July 7, 1907, *536*. Bog and streamlet 1⅞ miles southwest of Mountainville, July 13, 1907, *615a*. Bog west of Trexlertown, November 14, 1908. Near Waldheim, ½ mile southwest of Mountainville, October 16, 1909. Vicinity of woods and creek 1⅜ miles southwest of Locust Valley, July 17, 1910, *2667*. Vicinity of bog 1⅞ miles east by northeast of Mountainville, October 1910, *H. D. Bailey*. Vicinity of mine holes ½ mile northeast of Lanark, November 5, 1910, *3074*. 1¼ miles south of Schnecksville, November 6, 1910, *3076*. 1⅛ miles south by southeast of Mountainville, November 12, 1910, *3104*. Bog and streamlet 1 mile south by southwest of Mountainville, November 12, 1910, *3108*; farther west, *3109*. Roadside,

south to southwest of Macungie, November 13, 1910. Streamlet ⅜ mile east of Shimersville, November 13, 1910, *3129*; streamlet 1⅜ miles southeast of Emaus, same date, *3132*.

This species is of such frequent occurrence on the South Mountains that it may be expected throughout in wet boggy situations, though apparently absent from some areas and portions of others. It is abundant at the Saegersville station, where, growing in a deep shaded boggy area, it inclines to luxuriance as it does at places on the South Mountains. Found in open as well as shaded situations. Fronds 8.8 dm. (3.2+5.6) long and 1.3 dm. wide represent maximum luxuriance. Fruits late in June. Sterile fronds evergreen, the fertile lasting into late fall or early winter. Variable.

DRYOPTERIS CRISTATA×MARGINALIS Davenp.

General vicinity of streamlet at Mountainville, 1900, *Hamm.* Streamlet ½ mile east of Mountainville, June 22, 1901, *74*. In bog and along streamlet 1⅞ miles southwest of Mountainville, July 13, 1907, *615a*. Boggy area ¼ mile south of Saegersville, June 20, 1908, *1272b*. General vicinity of bog 1 mile south to southwest of Mountainville, November 12, 1910, *3111*; corresponding area about ¼ mile west, *3114*. Along road about ⅞ mile south to southwest of Macungie, November 13, 1910, *3115*. Vicinity of streamlet 1⅜ miles southeast of Emaus, November 13, 1910, *3133*.

This hybrid, as the stations show, is widely distributed on the South Mountains and it is quite safe to say that it may be expected throughout in favorable habitats where its putative parents are present. Rare at all of the stations, though at some of the stations on the South Mountains a number of plants are present. Mostly in shade but has been collected in the open. One fertile frond 10.4 dm. (2.7+7.7) long and 2.3 dm. wide has been collected but represents rather above maximum luxuriance. Fruits late in June. Fronds early prostrate, the sterile of some plants lasting well through the winter. Fertile fronds perhaps hardier than those of *D. cristata*.

In general the fronds collected in the county have been remarkably regular in outline and usually offer little difficulty in

identification in the field. Material collected previous to August, 1907, by Mr. Hamm and the writer, lay undetected and not definitely assigned until identified by Dr. Dowell, who visited the writer at that time for the purpose of collecting this hybrid growing in the open. While the measurement given is unusual, clumps of this hybrid occur in which the fronds incline to luxuriance and do not fall far short of these figures.

DRYOPTERIS GOLDIANA (Hook.) A. Gray

Boggy area and along streamlet 1¼ miles northwest of Strassburg, *Krout;* July 14, 1907, *639*. Along streamlet 1⅜ miles southwest of Locust Valley, *I. S. Moyer;* September 12, 1909, *2185*. Along streamlet 1 mile south by southeast of Spring Valley, May 15, 1900, *C. N. Lochman*.

Gaining in abundance at the first named station and fairly abundant at the second, where the trees have been cut from the low area on which the species grows. The second station, discovered by Dr. I. S. Moyer, the Bucks County botanist, is that of the published record in the Bucks County lists. The station is very close to the county line but in Lehigh. Bucks has however an authentic record of this species from Buckwampum. One frond 11.9 dm. (4.8+7.1) long and 5.5 dm. wide, representing rather above maximum luxuriance, has been recorded from the first station, where however the species rather inclines to luxuriance. Collected with mature fruit on July 4. Herbaceous, withering early but still green in November, though usually prostrate at that time.

Apparently, this species is local in its distribution in this region.

DRYOPTERIS INTERMEDIA (Muhl.) A. Gray

General throughout, on all soils and formations in moist situations, sometimes in niches on rocks and outcrops. Frequent and most abundant on the South Mountains. Fronds 6.6 dm. (2.1+4.5) long and 2.6 dm. wide represent average luxuriance. Collected with ripe fruit on June 20. Evergreen, lasting through the winter but early prostrate.

DRYOPTERIS INTERMEDIA×MARGINALIS Benedict

A fine plant of this hybrid was discovered in a low, moist shaded area in the vicinity of the abandoned mine holes along

Saucon Creek, ½ mile northeast of Lanark, November 5, 1910, *3073*.

DRYOPTERIS MARGINALIS (L.) A. Gray

General throughout, on all soils and formations and in many situations. Frequently abundant. Often in niches and fissures on outcrops. Frequently a roadside species in the vicinity of woods. Fronds 8.9 dm. (2.9+6) long and 2.8 dm. wide represent average luxuriance. Collected with ripe fruit on July 4. Evergreen but mostly prostrate by November. Variable.

DRYOPTERIS NOVEBORACENSIS (L.) A. Gray

General throughout, but most abundant on the South Mountains, where the species sometimes occupies areas of limited extent in almost pure association in the rich woods. Fronds 5.7 dm. (0.8+4.9) long and 1.5 dm. wide represent maximum luxuriance. Fruits in July. Herbaceous, withering early.

DRYOPTERIS SPINULOSA (Müll.) Kuntze

General throughout, associated with *D. intermedia*. Most abundant on the South Mountains, where it occurs in association with *D. intermedia*, but never even approaches this species in abundance. In general not nearly as luxuriant as the latter species. Collected in fruit on June 14. Tender, evergreen, mostly turning yellow early, but some fronds lasting well toward winter.

This and *D. intermedia* are very variable and, approaching each other closely, offer great difficulty in identification. Dr. Dowell has collected forms (general vicinity of bog 1 mile south by southwest of Mountainville, August 25, 1907, *Dowell 5112*) that are undoubtedly hybrids. These specimens, and material apparently identical with them in the writer's herbarium (*803*), have been referred here. Material from along the Kittatinny Mountains in the vicinity of Bake-oven Knob (June 21, 1908, *1284b*) has also been referred here. This intergrading of the species probably affects the comparative hardiness of the species, an associated character well marked in typical forms.

DRYOPTERIS THELYPTERIS (L.) A. Gray

General throughout. May be expected usually in abundance in all marshy meadows throughout and in favorable habitats

elsewhere. Varying greatly in length of stipe according to situation. Fronds 7.8 dm. (4.3+3.5) long and 1.4 dm. wide represent average luxuriance. Collected with ripe fruit on August 4. Herbaceous, withering early.

FILIX BULBIFERA (L.) Underw.

Moist limestone cliffs, Helfrich's Springs, 2⅛ miles west by northwest of Allentown, June 21, 1901, *Dowell, 1124*.

Moist hillside ½ mile west of Jordan Bridge, July 17, 1901; September 2, 1907, *849*. Moist shale cliffs ½ mile east northeast of Rockdale, August 15, 1908, *1442*.

On the wet shale cliffs in the vicinity of Rockdale along the Lehigh River, and northwest to below Slatington, this species is not rare. At the Jordan Bridge station it grows abundantly in the open on the moist limestone talus slope, but elsewhere in generally shaded situations. It may be looked for elsewhere in similar situations on these formations. Fronds 5.4 dm. (1.3+4.1) long and 1 dm. wide represent average luxuriance. Fruits in July. Herbaceous, withering early.

FILIX FRAGILIS (L.) Underw.

Lehigh Mountain, *Krout;* Laurel Hill, *Krout.*

Along first streamlet ½ mile east of Mountainville, June 8, 1900, *Hamm.* Wet situation along road ⅝ mile northwest of Strassburg, May 4, 1907, *Hamm;* May 18, 1907, *252.* ¼ mile south by southwest of Kernsville, April 25, 1908, *1078.* Wall of race, Helfrich's Springs, 1⅞ miles northwest by north of Allentown, May 5, 1908. Roadside 1 mile west of Emaus, May 24, 1908. Shale cliffs ½ mile east of Rockdale, April 9, 1910. Shale cliffs 1¼ miles southeast of Slatington, May 5, 1910, *2402.* ½ mile northwest of Kernsville, November 6, 1910.

Not rare at any of the stations given and often abundant. A frequent species on the shale cliffs from below Rockdale to below Slatington. May be expected in moist situations on the outcrops of these formations. Fronds 2.7 dm. (1.2+1.5) long and 7.5 cm. wide represent average luxuriance. Fruits late in May. Herbaceous, withering early, but fresh growth late in the season often lasting well into fall.

(?) LYGODIUM PALMATUM (Bernh.) Sw.

The published record for Lehigh County for this species is based on a specimen in the herbarium of the Philadelphia Botanical Club bearing a label which reads Carbon, Lehigh County. There is no Carbon in Lehigh County and Dr. Krout was very glad to correct this error when it was brought to his attention. The plant had been given to him. Mr. E. D. Leisenring reported this fern to Dr. Krout as occurring on the South Mountains south of Mountainville and a trip was made to locate this station. The fern was not found and though the habitat is promising, it likely never occurred in the county.

The species occurs at a number of stations over the Pocono plateau and its extensions, from Monroe through Carbon and Luzerne counties as far as Schuylkill, with a record from Wyoming still farther north. It occurs also in Bucks and Philadelphia counties in Pennsylvania and at a number of stations in New Jersey, all however in the Carolinian. The only connecting station is apparently the one based on a specimen collected by Knipe at Delaware Water Gap in the herbarium at the Academy of Natural Sciences at Philadelphia. The distribution of the species in this general region is not without interest.

MATTEUCCIA STRUTHIOPTERIS (L.) Todaro.

This record is now chiefly of historical interest. Dr. A. F. K. Krout found the species well established at several places in the "Lowlands" along the Lehigh River at Coplay, but all were destroyed while he still continued a resident of the county, by the slag dumps of local iron furnaces. The stations in Northampton County along Hokendauqua Creek and near Nazareth have also disappeared.

The species is not rare in cultivation at Allentown, and recently the writer saw it planted about a Slatington residence. It is not unlikely that it may still exist in some isolated habitat in the county. The species is recorded southward at stations along the Delaware and can still be collected at places along this stream in Northampton and Bucks counties in Pennyslvania.

ONOCLEA SENSIBILIS L.

General throughout, growing in shade and in the open on all soils and formations. Has been recorded in one instance from a

shaded bog as "waist high" or approximately 1 m., which is rather over maximum luxuriance. Fruits late in July. Herbaceous, early withering, the fertile fronds persistent through the winter.

The *obtusilobata* form has not been collected but may be looked for with the type.

OSMUNDA CINNAMOMEA L.

General throughout, in moist or wet situations. Most abundant in the vicinity of the Kittatinny and South Mountains where in the bogs it not infrequently attains a height of 1.74 m. Fruiting by the middle of May but has been recorded as early as May 2. In the open, plants with 15 fertile fronds have been noted while 8 to 10 are not infrequent. Fertile fronds less abundant in shade. Herbaceous, the pinnae which are variable in outline early withering, the stipes persistent.

The *frondosa* form has been collected. (On the South Mountains along the Lehigh River, May 12, 1899, *Hamm.*)

OSMUNDA CLAYTONIANA L.

General throughout, but preferring drier situations than *O. cinnamomea*, though occasionally associated with it. Reaching the height of 1 m. in luxuriance, but usually lower in height than *O. cinnamomea* when associated with that species. A frequent species of the wilder roadsides and in such situations sometimes abundant. Fruiting with *O. cinnamomea* and herbaceous as in that species.

OSMUNDA SPECTABILIS Willd.

General throughout, in wet situations. Most abundant in bogs and marshes in the vicinity of the Kittatinny and South Mountains. Approximately 1 m. in height in luxuriance. Fruits in general later than *O. cinnamomea*, with which it is frequently associated. Herbaceous.

PELLAEA ATROPURPUREA (L.) Link

Though absent from some outcrops this species is so frequent on limestone and shale outcrops that it is to be expected everywhere in the county on outcrops of these formations. Along the

little Lehigh and Cedar creeks it is frequent on limestone and as far as the vicinity of Jordan Bridge along the Jordan. On the shale outcrops along the Jordan it is not infrequent but less abundant. On the limestone and shale outcrops along the Lehigh River it is present rather abundantly not only in the county but as far as Easton in Northampton County and Phillipsburg in New Jersey. At the former place it may be seen growing on a wall along a street near the Central Railroad of New Jersey station, and at Lehigh Junction, Phillipsburg, it grows abundantly on walls enclosing the stairway to the overhead railroads.

In the county it is also perfectly at home and often occupies chinks in the walls of abandoned limekilns, railroad abutments, etc. The manner in which it has occupied comparatively recently abandoned limestone quarries stamps it as a permanent resident in the county.

It grows practically in shaded as well as open situations, and in exposed situations can often be found withered in seasons of protracted drought. The size of the fronds is due to exposure and lack of moisture no less than peculiar situations that make a longer stipe necessary. Fertile fronds 7 cm. (3+4) long and 2 cm. wide are not infrequent and fronds 4.1 dm. (1.6+2.5) long and 1.1 dm. wide have been collected. Has been collected well fruited on July 10. The species is evergreen. In severe cold weather the pinnules shrivel but are not dropped from the stalk.

PHEGOPTERIS HEXAGONOPTERA (Michx.) Fée

All of the writer's records are from the South Mountains but it is likely that this species occurs in the vicinity of the Kittatinny Range as well as elsewhere. A record of P. A. Lantz for Saegersville, September 25, 1875, would mean shale formation, if the species was actually collected at that place. If the writer has seen it on shale or limestone the fact has escaped him. It is a frequent and often abundant species in shaded and open situations on the South Mountains and appears equally at home in wet or drier situations. Sometimes it occurs in patches of pure association in the more open woods. Fronds 5.6 dm. (3.6+2) long and 2.3 dm. wide represent average luxuriance. One frond from a moist situation, 7.2 dm. (4.6+2.6) long and 2.9 dm. wide, has been collected.

Collected with ripe fruit on August 1. Herbaceous, withering early.

Forms occur in the bogs or along the streams on the South Mountains which simulate closely the characters of *P. Phegopteris*. It has been suggested that farther south the species intergrade, and perhaps some such forms exist here.

PHEGOPTERIS PHEGOPTERIS (L.) Underw.

General and often abundant on the moist shale cliffs along the Lehigh River from Cementon to near Slatington. Laurel Hill, 1878, *Krout;* Cementon, July 11, 1908, *1325;* Rockdale, August 15, 1908, *1468*. Fronds 3.9 dm. (2.6+1.3) long and 1 dm. wide are rather below average though the fronds are never very large. Collected with ripe fruit on July 11. Herbaceous, withering early.

POLYPODIUM VULGARE L.

Frequent throughout, on outcrops of all formations. It has been found growing in the cleft trunks of trees and occasionally on loose talus. Less abundant on limestone but on rocks in the mountains, and especially on the shale outcrops it is often very abundant, not infrequently in pure association. Varies greatly in size according to situation. Most luxuriant in rich leaf mold on the shelves of outcrops, and in such situations frequently 3.4 dm. (1.2+2.2) long and 7 cm. wide, which represents average luxuriance. Fruits in summer, is evergreen and may be collected well into winter, when severe cold causes the fronds to roll up to decrease radiation. In general constant to type but with variations probably referable to certain described forms or varieties.

POLYSTICHUM ACROSTICHOIDES (Michx.) Schott

Frequent throughout, on all soils and formations and in all situations, but most abundant in moist (not wet), often rocky situations on wooded hillsides and along small streams, and in the vicinity of shaded bogs in woods. Also a frequent roadside species in the vicinity of woods. Fertile fronds 7.9 dm. (2.6+5.3) long and 1.2 dm. wide have been collected and represent average luxuriance. Fruits in July. Evergreen but prostrate in November when the fertile portion of the frond is usually withered. The

species is very variable in the cutting of the pinnae, and the varieties *Schweinitzii* and *crispum* occur with the type.

PTERIDIUM AQUILINUM (L.) Kuhn

In the vicinity of the mountains in open situations but not infrequently in woods in shade. Usually abundant over large areas. In favorable habitats as high as 1 m. but usually lower, especially in drier, less open situations. Has been collected heavily fruited on July 4. Herbaceous but lasting well into fall, the dried plants persistent into winter.

It is not unusual to find that "common" species like this are slighted in observations. When the writer began this list he found he had taken a number of records for this species, but they were all of the mountains where sandy soil formation are the rule. It was too late to follow up the particular observation that suggested itself and which the reader will suspect. The writer does not believe in presuming too strongly on observations so he will ask the question: Does this species prefer sandy soil formations and does it avoid any others? Since this question has arisen in the writer's mind he has tramped for miles in shale and limestone country in the county and has found the brake absent from numerous favorable habitats. He has found it sparingly at two places on shale. None was seen for miles along the upper Jordan Creek. Does the soil have anything to do with the relative frequency and abundance of this species?

WOODSIA ILVENSIS (L.) R. Br.

This species was collected in 1878 by Dr. A. F. K. Krout, near Kernsville, on shale outcrops along the Jordan. On a trip undertaken to confirm this record, for which a specimen exists, this species was found fairly abundant on the outcrops ½ mile northwest of Kernsville, May 9, 1909, *1763*, and since then it has been found still further up stream 1⅛ miles northwest of Kernsville, November 6, 1910, *3098*. The outcrops are shaded, at least in part, and the species, which is fairly abundant, is inclined to luxuriance beyond the average. Fronds 1.9 dm. (0.7+1.2) long and 3 cm. wide are little above average luxuriance. Collected heavily fruited on June 26. Herbaceous, but green fronds have been collected as late as November 6.

WOODSIA OBTUSA (Spreng.) Torr.

Of frequent occurrence and often abundant on the shale and limestone formations, especially on outcrops and in rocky woods along the Jordan Creek and the Little Lehigh River. It may be expected throughout on these formations. Recorded on the South Mountains from Lower Milford (Krout), along the Lehigh River (May 19, 1900, *Lewis A. Ink*, in Muhlenberg College herbarium), and Vera Cruz (February 22, 1908). There is no record from the Kittatinny Mountains. Very abundant ½ mile northwest of Kernsville along the Jordan. Grows in the open and in the shade. Fertile fronds 4.1 dm. (1.5+2.6) long and 6 cm. wide represent average luxuriance. Collected well fruited on June 26. The sterile fronds are half evergreen and in "rosettes" last well over winter.

EQUISETUM ARVENSE L.

Common in about the frequency and usual great abundance for this general region. Fruits in early spring. (April 13, 1907, *149*.) Herbaceous.

EQUISETUM FLUVIATILE L.

Occurs in great abundance often in patches of practically pure association, in wet situations in the low meadows along the Little Lehigh, from opposite 10th Street, Allentown, westward as far as 12th Street (May 30, 1900, *Dowell 799*), and at the mouth of Cedar Creek (*E. S. Mattern*). Also shores of the Lehigh River, near Slatington (*Krout*), and 1½ miles east by southeast of Allentown along the canal (October 3, 1909). Fruiting plants 8.2 dm. and sterile plants 9.5 dm. high represent average luxuriance at the first named station, where the plants grow in the open and fruit abundantly in May (May 28, 1909, *1849*). Herbaceous, withering early.

EQUISETUM HYEMALE L.

Not infrequent in woods along the Jordan Creek and Little Lehigh River. Also at Coplay (*Krout*) and in abundance within a limited area between the canal and the Lehigh River, approximately 2 miles east of Allentown (December 5, 1908.) 1 m. in height at this station but lower elsewhere. Collected fruiting in fall (½ mile west of Jordan Bridge, October 6, 1901, *Dowell 1329*) but not in early spring. Evergreen.

The species is the form typical for the region, described as *E. hyemale affine* (Engelm.) A. A. Eaton.

EQUISETUM SYLVATICUM L.

Infrequent in the bogs on the South Mountains, where it is rare in fruit. Very abundant and freely fruiting in an open marsh southeast of the Bake-oven Knob on the Kittatinny Range (April 30, 1910, *2357*) and presumably present elsewhere in the vicinity of this range. Sterile plants 5.3 dm. high represent average luxuriance. Collected in fruit on April 30. Herbaceous, withering early.

LYCOPODIUM CLAVATUM L.

In the general vicinity of the bog 1 mile south by southwest of Mountainville, on the South Mountains, there are three places where this species has been found (October 5, 1907, *1007*), and it has also been collected 1 mile south by southeast of Mountainville (March 6, 1910; November 12, 1910, *3102*). It occurs sparingly near a moist open area in a quarrylike exposure of Hardyston sandstone, on the spur of the South Mountains along the Lehigh River, 5/8 mile northeast of Strassburg (May 31, 1908; October 29 1910, *3049*). It is nowhere abundant and has not been found in fruit. Evergreen.

This species is not infrequent, often abundant and usually well fruited, in the mountains near Mauch Chunk in Carbon County and near White Haven in Luzerne County, to the northwest, but has been seen nowhere in Lehigh County growing in these apparently normal conditions. Though the species has been collected well to the southeast of the mountains, in Pennsylvania, it can be said to be an infrequent or even rare species in Lehigh County.

LYCOPODIUM COMPLANATUM L.

General throughout, but local in its occurrence and frequently abundant. Growing in open and shaded situations and on all soils and formations. Less frequently fruiting but usually more luxuriant in shade than in the open. Fruits late in August. Evergreen.

The species is the form typical for the region, described as var. *flabelliforme* Fernald.

LYCOPODIUM INUNDATUM L.

In an open, sandy, springy bog at the head of Black River, 1 7/8 miles east by northeast of Mountainville, on the South Mountains, southeast of Allentown, July 27, 1900, *Dowell 860;* Kittatinny Mountains, north of Lehigh Furnace, September 22, 1907, *967;* and north of Slatedale, September 22, 1907, *977;* moist area in quarrylike exposure of Hardyston sandstone on Lehigh Mountains, along Lehigh River, between the road and railroad 5/8 mile northeast of Strassburg, October 29, 1910, *3041.*

Rare excepting at the station north of Lehigh Furnace, which consists of a very limited boggy area heading a rivulet, where a spring seeps out over an old lumber trail. In the cold sphagnum and grass the plant is found. The habitats at the other stations are similar. All are on sandy soil formation and are indifferent to shade, growing equally well without the protection of grasses, etc. Trailing stems sometimes branched, in luxuriance 9 cm. long with fruiting stems 9 cm. high. Fruiting stems less than 4 cm. high have been collected.

Apparently the only records for this species in Pennsylvania south of the Kittatinny Range are from Lehigh County.

LYCOPODIUM LUCIDULUM Michx.

Frequent and usually abundant, sometimes in patches of pure association, in cold shaded bogs and similar situations along streamlets, on the Kittatinny and South Mountains. Not infrequently very abundant locally. Has been collected in the vicinity of a cold shaded springhead on "shale" along the Jordan Creek, 1 1/4 miles west to northwest of Kernsville, November 6, 1910, *3094,* and farther up stream it occurs sparingly on the moist wooded slopes facing north. Sometimes luxuriant, exceeding 2.3 dm. in height, but usually between 1 and 2 dm. high. Freely fruiting in fall. Evergreen.

LYCOPODIUM OBSCURUM L.

A frequent species on the Kittatinny and South Mountains, often locally abundant. Apparently less frequent on limestone and shale but to be expected throughout. Plants 2.4 dm. high are rather above average luxuriance. Collected in ripe fruit from late August to late November. Evergreen.

SELAGINELLA APUS (L.) Spring.

General throughout, in moist, springy and often marshy, open meadows and bogs. Usually abundant. Collected on wet "shale" outcrops along the Jordan Creek, 1⅛ miles northwest of Kernsville, November 6, 1910, *3100*. Collected in fruit on August 25. A conspicuous species in late fall and early winter among the grasses in the open meadows. Evergreen. Has been found in January apparently as fresh and untouched by the cold as earlier in the season.

ISOËTES CANADENSIS (Engelm.) A. A. Eaton

Collected along the Lehigh River, about a mile above Bethlehem, in August, 1882, *Eugene A. Rau*. This plant, which Mr. Rau has told the writer was originally collected by Elias Durand, the Philadelphia botanist, on a trip up the Lehigh River, was referred to "*I. Engelmanni* A. Br." but changed later. A note on Mr. Rau's label refers to the TORREY BULLETIN for June, 1903.*

In this list variation has not been especially emphasized. The writer has collected in the county many forked fronds of ferns of different species, plants of *Botrychium obliquum* Muhl. with two or even three fertile fronds, etc., which may be considered abnormal growths and of which it is unnecessary to make any particular mention.

What has been said in reference to the Botrychiums applies even better to the genus *Dryopteris* or more properly to that division characterized as the *cristata-marginalis-spinulosa* group. Contributions concerning the hybrids of this group are to be found in current botanical literature. These contributions contain also many observations relating to the described species themselves and materially advance the knowledge of the group. All of the members of the group indigenous to this region, excepting *D. Goldiana*, which is rather local, are to be found more or less evenly distributed in a number of habitats in the South Mountain range. In view of the acknowledged difficulty of the group, with particular reference to its hybrids, the writer has made little mention of the variation to be found. As to the identity of the material cited, the writer

* Bull. Torrey Club 30: 359–362. 11 Je 1903.

is especially glad to make grateful acknowledgment to Dr. Philip Dowell for examining all his collections in this group.

SUPPLEMENTARY NOTES

Some notes on the following species, which may be called "near neighbors," may be of interest:

Asplenium pinnatifidum Nutt. Judging from published records, the collection of this species in the county would be not only surprising but unexpected.

Athyrium angustifolium (Michx.) Milde. Reported among other counties in Pennsylvania from Berks, Montgomery, and Monroe. Its occurrence within the limits of the county would not be surprising.

Dryopteris Clintoniana (Eat.) Dowell. Accepting the published records for this species without questioning the identification, it is possible that this species may yet be collected in the county.

Dryopteris simulata Davenp. Porter records this species from Schuylkill, Pike, and Monroe counties, in the mountains to the north, and the writer has found it abundant on Broad Mountain, near Mauch Chunk, in Carbon County, and near Saylorsburg in Monroe County. It has also been reported from Bucks County, and southeast in New Jersey. The writer has recognized the possibility of the fern occurring in the county but careful search has not resulted in finding it.

Lorinseria areolata (L.) Underw. The only excuse for mentioning this species is the published record for Monroe County, Pennsylvania. Normally this is a coastal species with few records of its occurrence far inland. Apparently Carolinian in its association, its occurrence in the county is not expected.

Ophioglossum vulgatum L. There are records for this species from nearly every county adjoining Lehigh but the writer has looked over many favorable localities with the species in mind without favorable result. Its occurrence may almost be assumed but its collection will probably be accidental, like so many of the records of this species.

Phegopteris Dryopteris (L.) Fée. There is every reason to believe that this species should occur in Lehigh County, as it is reported from so many of the adjoining or neighboring counties, but thus far it has not been collected.

Lycopodium annotinum L. This species has been collected by the writer at an altitude of approximately 400 m., in a ravine on Broad Mountain, near Nesquehoning, Carbon County, facing south. Porter collected it in the Poconos, and its extension southeast along the Kittatinny Range is not unreasonable.

Lycopodium tristachyum Pursh. There are apparently no records for this species in eastern Pennsylvania southeast of the mountains, but in the Flora Cestrica, under the species *L. complanatum*, occurs the following footnote:

"Obs. My friend, JOSHUA HOOPES, finds specimens on our slaty hills, which he regards as almost specifically distinct,—having trailing *stems* mostly buried and rhizome-like, the *branches* of a brighter green, the ultimate *branchlets* not so coarse, and twice as numerous, while the *spores* are matured two or three months earlier than the common form."

What was this plant that Joshua Hoopes observed in Chester County, Pennsylvania? The seventh edition of the Gray Manual gives the range of this species as "Me. to Del., etc." Its occurrence in the county would not be surprising.

Selaginella rupestris (L.) Spring. Records show this species to occur in Pike, Monroe, Northampton, Berks, Chester, Lancaster, and Bucks counties in Pennsylvania. There is as yet no record for Lehigh.

Notes on Rosaceae—V

POTENTILLA (*Continued*)*

Per Axel Rydberg

Frigidae

In the North American Flora I recognized five species of this group. No essential change was made from my treatment of the group in my monograph, except that I united *Potentilla nana* Willd. with *P. emarginata* Pursh. My conception of *P. nana* had been that it was the same as *P. fragiformis parviflora* Traut., i. e., a depauperate *P. emarginata* with blunter leaves, bractlets, and sepals. Dr. Th. Wolf, who has seen the type of *P. nana*, claims that it is a depauperate *P. fragiformis* instead. The main distinction between *P. emarginata* and *P. fragiformis*, according to Dr. Wolf, is that in the former the styles are scarcely longer than the achenes, while in the latter they are fully twice as long. In *P. emarginata* the styles are short, it is true, but as far as *P. fragifomis* is concerned I have not been able to verify Dr. Wolf's statement. In all the specimens at my disposal the flowers are very young, and the achenes undeveloped, but the styles do not seem very long. Dr. Wolf may be correct, however. At all events *P. nana* should be reduced to a synonym.

Dr. Wolf has also criticised my plate of *P. fragiformis* in my monograph, and rightly so. In the specimen used for the illustration of the plant, the petals had fallen, and I instructed the artist to draw the flower from another specimen, which had better flowers but was otherwise scrappy. Apparently he did not follow my instruction, for the flower represents *P. emarginata* or *P. nivea.*

Dr. Wolf divides the species of this group between his Ranunculoides and Aureae, referring *P. flabelliformis* and *P. fragiformis* to the former and the rest to the latter group. See my remarks under the Aureae † group concerning this treatment. *P. Friesiana* is regarded by Dr. Wolf as a ternate variety of the quinate *P. alpestris*, i. e., *P. maculata* as understood in America.

*See Bull. Torrey Club 37: 487–502. 28 O 1910.

† Bull. Torrey Club 37: 495. 28 O 1910.

BIFLORAE

This group consists of but one species. Dr. Wolf places the group in his section POTENTILLAE TRICHOCARPAE subsection NEMATOSTYLAE, i. e., in a section with hairy ovaries and the filiform style attached at or below the middle of the ovary. The only American species that should be counted to this section is *P. tridentata* or my genus *Sibbaldiopsis*. In his characterization of the group, Dr. Wolf states that the achenes of *P. biflora* only have a bunch of hairs at the scar of insertion. So far as I know they are not hairy at all and the bunch of hairs referred to are the hairs of the receptacle found in all the *Potentillae*. These are unusually long in *P. biflora*. The style in this species is also almost terminal, just as in many typical species of the genus. It is evident that Dr. Wolf has placed this as well as *P. palustris* in a wrong division of the genus.

SAXOSAE

This group consists of three species from Southern California and Lower California. They have much the habit of certain species of *Ivesia*, and for some time I regarded the first known species of the group, *Potentilla saxosa*, as a member of *Ivesia*. Dr. Wolf places *P. saxosa* and *P. rosulata* in the MULTIJUGAE group, but I think that they differ enough from that group to constitute a group by themselves. *P. acuminata* Hall is so closely related to these that I was strongly inclined to reduce it to a synonym of *P. rosulata*. The only essential differences are the thinner leaves and narrower bractlets. Dr. Wolf places it in the RANUNCULOIDES group (a group with digitate leaves), perhaps because the plant is glandular, as is *P. brevifolia*, another pinnate-leaved species referred to the same group by him. On account of the glandular pubescence, Hall thought at first the plant related to the GLANDULOSA group, i. e., the genus *Drymocallis*, and also compares it with *P. brevifolia*. The latter could easily be taken for a species of *Drymocallis*, if the style is disregarded; but *P. acuminata* does not resemble a species of that genus so much. Dr. Wolf remarks: "What separates *P. acuminata* not only from all other species of this group [RANUNCULOIDES of Wolf] but also from all other known Potentillas of the Earth—with the exception of

P. palustris [*Comarum* L.]—are its narrowly ovate, long-acuminate petals." This character would at once have suggested its relationship with *P. saxosa*, for the latter was originally described as having acute petals. Dr. Wolf, however, seems not to have seen the original description, for he only translates my short description into Latin. In my monograph I gave only abbreviated descriptions of the species not found within the United States and Canada.

BREVIFOLIAE

No change in this group has been made since my monograph was published. It consists of only two species, which Dr. Wolf includes in his RANUNCULOIDES. Dr. Wolf claims that a piece of the type of Nuttall's *P. brevifolia* is in Lehmann's herbarium and that this has ternate leaves. Occasionally the basal leaves may have but three leaflets, but this is not the usual case. I have seen Nuttall's type, and a duplicate is in the Torrey herbarium; in both the basal leaves are pinnate with five leaflets.

RUBRICAULES

In the North American Flora I recognized nine species. Of these *Potentilla proxima* was described as new. It is related to *P. Macounii*, but distinguished by the toothed, not deeply cleft leaflets. It is also of a much more southern distribution, found only in south central Utah and Arizona, while *P. Macounii* is found only in Alberta and Montana. The following specimens belong to *P. proxima*:

UTAH: Divide between Sevier and Beaver rivers, near Belknap Peak, July 28, 1905, *Rydberg & Carlton 7369;* also Aquarius Plateau, Aug. 6, 1905, *7479;* mountains north of Bullion Creek, near Marysvale, July 23, 1905, *7157* and *7153*.

ARIZONA: Southern slope, San Francisco Mountains, August, 1904, *Cannon & Lloyd*.

My description of *Potentilla rubricaulis* Lehm. in my monograph was based principally on material collected in the Rocky Mountain region. The species was therefore described as having 5–7 leaflets, while the original has only 3–5 leaflets. I saw my mistake and made a correction in the BULLETIN of the Torrey Club,* proposing the name *Potentilla rubripes* for the Rocky

*Bull. Torrey Club 33: 143. 1906.

Mountain plant. Dr. Wolf has called attention to an important difference overlooked by me, viz., that the style in *P. rubricaulis* Lehm. is much thickened and glandular at the base. He therefore includes it in the MULTIFIDAE group. Dr. Wolf also reduces *P. minutifolia* and *P. saximontana* to varieties of *P. rubripes*. As far as *P. saximontana* is concerned it can not be kept distinct from *P. rubripes*. I have come to that conclusion by the aid of material sent me by Mrs. M. E. Soth and others from the Pikes Peak region. Concerning *P. minutifolia* I am still in doubt. If, however, the species are united, the name of the species should not be *P. rubripes*, which name Dr. Wolf adopts, because that is the latest of the three, being 10 years more recent than the other two, which were published on the same page, *P. minutifolia* preceding *P. saximontana* in space.

CANDICANTES

This group contains only one Mexican species, which Dr. Wolf includes in the MULTIJUGAE group.

LEUCOPHYLLAE

In the North American Flora this contains 12 species, of which *Potentilla lupina*, *P. argyrea*, *P. viridior*, and *P. Bruceae* are proposed as new. The first two were based on material formerly included in *P. Hippiana*. *P. lupulina* resembles much *P. Hippiana*, but the pubescence is coarser, less shining, and more gray, the bractlets are small and the sepals are acuminate as in *P. effusa*. It is known from only the type locality and vicinity, and all the material seen was collected by Mr. Frank Tweedy. It is represented by his numbers *3214* and *3215*, of which the latter was assigned as the type.

P. argyrea also is related to *P. Hippiana*, but differs in the dense inflorescence, dull tomentum, and smaller flowers. The dense inflorescence suggests somewhat certain species of the MULTIFIDAE group. One of the specimens was originally labeled *P. pennsylvanica*. Besides the type, the following specimens belong here:

NORTH DAKOTA: Willow City, July 18, 1891, *Lee 219*.

MANITOBA: Britte, June 27, 1906, *Macoun & Herriot 69836*. (This specimen is, however, somewhat doubtful.)

Potentilla Bruceae is related to *P. Breweri*, but differs in the fewer, broader, closely approximate pairs of leaflets. It is known from the type locality only.

Dr. Wolf includes the group in the GRACILES group, which he divides into two divisions. The first, GRACILES PINNATAE, comprises my GRACILES, RUBRICAULES (except *P. rubricaulis* Lehm.), and SUBJUGAE. He makes *Potentilla propinqua* Rydb. (*P. diffusa* A. Gray, not Willd.) a variety of *P. Hippiana*, and both *P. coloradensis* and *P. rupicola* varieties of *P. effusa*. If the author can be accused of splitting up the species too finely, Dr. Wolf especially in this case can be accused of lumping together rather clearly distinct species. *P. propinqua*, as known from field study, shows itself very distinct from *P. Hippiana*, but much less so from the typical *P. pulcherrima*. Sereno Watson saw this close relationship and united the two under the name *P. Hippiana* var. *pulcherrima*. The main differences are that *P. propinqua* is usually lower, decumbent at the base, and its leaves have 9 leaflets, directed somewhat forward; while *P. pulcherrima* is usually taller, more erect, and its leaves have generally only 5–7 leaflets, of which the lower are spreading or even reflexed. Concerning the relationship of *P. pulcherrima* to *P. gracilis* and *P. filipes*, see my remarks in the BULLETIN OF THE TORREY BOTANICAL CLUB **37**: 491. 28 O 1910.

Dr. Wolf proposes a new species, *Potentilla Osterhoutiana*.* I have not seen the type nor any duplicate thereof. From the description, it seems to me to be a luxuriant form of *P. rubripes* or else the same as my *P. viridior*. I have written to Mr. Osterhout for material, but he has answered me that he has no specimens of the number cited by Dr. Wolf. He does not know what it is. From the date and locality given he thinks that it may be *P. rubripes*.†

MULTIJUGAE

This group contains, in the North American Flora, sixteen species, of which *Potentilla klamathensis*, *P. versicolor*, and *P. Nel-*

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* Bibl. Bot. **16**: 200. 1908.

† After this article was written, Mr. G. E. Osterhout has sent me a specimen, *Osterhout 1502*, which he thinks might be *P. Osterhoutiana*. It is an unusually large specimen of *P. rubripes*. The only thing that speaks against this being a duplicate of the type of *P. Osterhoutiana* is that it was collected July 12 instead of July 20.

soniana were proposed as new, and *P. crinita* and *P. Lemmoni* were transferred from the LEUCOPHYLLAE group.

Potentilla klamathensis is related to *P. millefolia* and *P. Hickmani*, but differs in the long, ascending, at last spreading pubescence. Dr. Wolf cites a specimen under *P. millefolia*, from Goose Lake. This is perhaps Cusick's specimen cited below, as *P. millefolia* is unknown outside of California. The following specimens belong to *P. klamathensis*:

OREGON: Fort Klamath, Aug. 7, 1894, *Leiberg 660;* Swan Lake, Klamath Co., 1896, *Applegate 167;* Goose Lake Valley, Aug. 19, 1901, *Cusick 2768.*

Potentilla versicolor resembles *P. plattensis* in leaf form, but the younger leaves are tomentose as well as strigose, and the pedicels are erect or ascending, not arcuate-spreading in fruit. The species is therefore more closely related to *P. ovina* and *P. wyomingensis*, but is distinguished by the tomentum. It is known from the type locality only.

Potentilla Nelsoniana is based on *P. pinnatisecta* A. Nels.,* as to the description and specimens distributed by Professor Nelson. He adopted the name from *P. diversifolia* var. *pinnatisecta* S. Wats.† An examination of Watson's type shows that it is the same as *P. ovina* J. M. Macoun.‡ Dr. Wolf makes it a variety of *P. plattensis*, stating: "I have tried for long time but in vain, to find on specimens received from the author of the species (Mr. Aven Nelson) himself characters specifically distinctive from *P. plattensis*. . . . In the organs of the flowers as well as in all other important points, one can find between *P. plattensis* and *P. pinnatisecta* even with the microscope no distinctions which warrant a specific distinction." Both Professor Nelson and myself have studied the plants in the field. The main distinctions are as follows: *P. plattensis* has a deep taproot with a short perennial crown branching just at the surface of the ground and sending out numerous, decumbent, or rarely ascending, leafy stems, with numerous flowers on pedicels which at least in fruit are arcuate-spreading. In both *P. Nelsoniana* and *P. ovina* there is a distinct

*Wyo. Exp. Sta. Bull. 28: 104. 1896.

† Bot. King's Exp. 87. 1871.

‡ Can. Rec. Sci. 6: 464. 1896.

cespitose, scaly, thick subterranean rootstock, the branches of which bear at the summit numerous basal leaves and short erect or ascending stems bearing only reduced leaves. The pedicels are in fruit erect or strongly ascending. These are characters that need no microscope to be seen. The distinction between *P. Nelsoniana* (*P. pinnatisecta* A. Nelson) and *P. ovina* (*P. diversifolia pinnatisecta* S. Wats.) are that the leaflets of the former are cuneate in outline, glabrate in age, and cleft only above the middle; while in *P. ovina* they are obovate in outline, permanently hairy, distinctly pectinately pinnatifid. The latter is a much smaller plant than the former.

Dr. Wolf also makes *P. wyomingensis* a mere form of *P. plattensis pinnatisecta*, and this is done evidently without having seen any specimens, for he states: "From the long diagnosis of the author can it absolutely not be seen how this 'species' can be specifically distinguished from his *P. pinnatisecta*." The fact is that the type of *P. wyomingensis* is a better developed specimen of *P. monidensis* A. Nelson, which Dr. Wolf regards as a distinct species. *P. monidensis* was described from specimens just coming into bloom. Aven Nelson, in the New Manual of the Central Rocky Mountains, keeps them distinct. The differences given, especially the form of the petals, do not hold.

Concerning *P. decurrens*, a species belonging to this group and most closely related to *P. ovina*, see my Notes on Rosaceae—IV.* As the type of *P. dissecta decurrens* was rather poor I herewith cite better material:

UTAH: Divide between Sevier and Beaver rivers, near Belknap Peak, July 28, 1905, *Rydberg & Carlton 7355;* mountains north of Bullion Creek, near Marysvale, July 23, 1905, *Rydberg & Carlton 7152;* Bromide Pass, 1894, *Jones 5695k.*

Dr. Wolf has also reduced *P. cascadensis* to a variety of *P. Drummondii*, which is simply a matter of opinion. He also places *P. crinita* and *P. Lemmoni* in the GRACILES PINNATAE next after *P. ambigens*, notwithstanding the fact that neither of them has any tomentum.

Potentilla Richardii is transferred to the RIVALES group on account of its style. Dr. Wolf may be correct. I have not seen

*Bull. Torrey Club 37: 495. 28 O 1910.

the type nor any authentic material. The habit, judging from Lehmann's plate, suggests, however, this group and is most like that of *P. arizonica*.

MULTIFIDAE

This group, as treated in the North American Flora, contains 16 species, of which *P. paucijuga* and *P. lasiodonta* are new. The former is probably most nearly related to *P. pseudosericea*, but the stem and petioles are silky-villous with spreading hairs, as in *P. pulchella*, and the inflorescence is open. I have seen no specimen except the type, which in habit resembles somewhat *P. rubripes*, but the styles are quite different and place the plant in this group. The type specimen is mounted on the same sheet with four specimens of *P. propinqua*.

Potentilla lasiodonta was based on material distributed as *P. pennsylvanica* and *P. strigosa*. It has the broad leaflets of the former and the pubescence of the latter, but differs from both in the dense inflorescence, similar to that of certain species of *Drymocallis*, and in the numerous lanceolate divisions of the leaflets. These number 15–21, while in *P. pennsylvanica* and *P. strigosa* there are 9–13. The following specimens belong here:

ALBERTA: Calgary, July 21, 1897, *Macoun 16716*.

SASKATCHEWAN: Tramping Lake, Aug. 4, 1906, *Macoun & Herriot 69810*.

MANITOBA: Rapid City, 1896, *Macoun 12576*.

The MULTIFIDAE are one of the most difficult groups of the North American species of *Potentilla*. The difficulty is to draw lines between species. A conservative botanist might admit but four or five species, viz., *P. pulchella*, *P. bipinnatifida*, *P. multifida*, and *P. pennsylvanica*, and maybe *P. virgulata*. Nelson, in the New Manual of the Central Rocky Mountains, admits *P. bipinnatifida* Dougl. (which he, however, has renamed *P. pinnatifida* Dougl.), *P. pennsylvanica* with two varieties, *P. atrovirens*, and *P. virgulata*. *P. pseudosericea*, he makes a synonym of "*P. pinnatifida*." *P. pulchella*, *P. multifida*, and their allies are not found in the Rocky Mountain region. Dr. Wolf admits *P. pulchella*, *P. pseudosericea*, *P. bipinnatifida*, *P. multifida*, *P. litoralis*, *P. pennsylvanica*, and *P. glabrella*. Note the differences of opinion. Nelson regards *P. atrovirens* and *P. virgulata* as good

species, while Wolf regards both as varieties of *P. pennsylvanica*. Wolf regards *P. pseudosericea* and *P. glabrella* as good species, while Nelson regards the former as a synonym of *P. bipinnatifida* and ignores *P. glabrella* altogether. When such a diversity of opinion exists regarding the limitation of the species, and I in my mind was just as uncertain which should be regarded as species and which as varieties or forms, I treated all that had some characters tolerably constant as distinct species.

Both Wolf and Simmons * regard *P. Sommerfeltii* as a variety of *P. pulchella*. Dr. Simmons states: "but there are in the London collections, no original specimens from Ross's first voyage and the specimens under the name of *P. pulchella* from Melville Island, that I have seen, are really *P. Vahliana*, to which, however, the description does not apply." In the old Torrey herbarium there are some specimens of the Melville collections, gathered by Parry. Two of these are *P. Wahliana* but one is *P. pulchella* as I understand it, a plant with leaves densely silky on both sides, slightly if at all tomentose beneath, and with narrow, linear, acute segments. *P. Sommerfeltii*, as I understand it, has leaves green and almost glabrous above, somewhat silky and densely white-tomentose beneath, with oblong, rather than linear, and obtuse segments. This is the common plant of Spitzbergen, but also found in arctic America.

The original *Potentilla Sommerfeltii* was collected by Keilhave and found in Sommerfelt's herbarium; it may be the same as *P. Keilhavii* Sommerf.,* which has always been regarded as a synonym of *P. pulchella*. As it has been impossible for me to see the original description of *P. Keilhavii*, I left it as a questionable synonym under that species.

If *P. Sommerfeltii* is regarded as a species, it would not be out of place to regard *P. pulchella elatior* as such. It has been customary to label all tall well-developed plants *P. pulchella* v. *elatior* and all depauperate ones *P. pulchella*. Without regard to size, there are evidently two distinct races (they may be called species, varieties, or forms) known as *P. pulchella*, beside *P. Sommerfeltii* discussed above. One is the typical *P. pulchella* just

* Vasc. Pl. Fl. Ellesmereland 479. 1906.

† Mag. Naturv. II. 1: 244. 1832.

briefly described. The other is usually, but not always, a larger plant, with the terminal leaflet decidedly petioled, the leaves dark green above, white-tomentose beneath, with oblong or lanceolate divisions and larger petals usually decidedly emarginate. I take it as the same as Lange's *P. pulchella elatior*, but as the name *elatior* is not available as a specific name I proposed the name *Potentilla subarctica*.

Dr. Wolf does not admit *P. multifida* to North America, although I included it in my monograph. We have, however, specimens from this continent, which I can not separate from Old World material. Among others may be mentioned the following specimens:

CANADA: Raft River, west coast of Hudson Bay, August 9, 1904, *Spreadborough 62383;* Pipestone Creek, Rocky Mountain Park, July 7, 1904, *Macoun 65150.*

Robinson and Fernald, in Gray's New Manual, reduced *Potentilla litoralis* Rydb. to a synonym of *P. pennsylvanica* L. Their idea of the latter was evidently based on that of Watson, for their description is copied verbatim from that in the sixth edition of Gray's Manual, except that the height of the plant is given in decimeters instead of feet. It is natural to suppose that a plant named *P. pennsylvanica* should have come from the east, and in the fifth edition of Gray's Manual the given range includes even "Pennyslvania?" It is entirely wrong, however, to apply the name *P. pennsylvanica* to our coast plant, which I described under the name *P. litoralis*.

Linnaeus did not describe his *Potentilla pennsylvanica* from a plant collected in Pennsylvania but from plants cultivated in the gardens of Europe under that name. Jacquin, in his Hortus Vindobonensis, illustrated it under that name, and if I am not mistaken Linnaeus had received his specimens from Vienna. Dr. Wolf, who admits *P. litoralis* as a good species states: "This [*P. pennsylvanica* var. *communis* T. & G.; *P. missourica* Schrader] is the true *P. pennsylvanica* of Linnaeus, the one figured by Jacquin, the one cultivated in the botanical gardens since Linnaeus' time and for long time escaped in the vicinity of Paris." Dr. Wolf therefore fully supports my interpretation of *P. pennsylvanica*. What it is, anybody may ascertain for himself by looking up the

illustrations of *P. pennsylvanica* in Jacq. Hort. Vind. 2: *pl. 189*, or *P. missourica* in Bot. Reg. 17: *pl. 1412*. 1831. The description in Gray's New Manual is not that of *P. pennsylvanica*, but of *P. litoralis* Rydb. Unfortunately for me the latter name has to give place to *P. pectinata* Raf., which is without doubt the same as our coast plant.

Dr. Wolf regards *Potentilla strigosa*, *P. arachnoidea*, *P. atrovirens*, and *P. virgulata* as varieties of *P. pennsylvanica*, but regards *P. glabrella* as a species. It has no better right to such a place than the rest. I have treated them all as species, although I regard *P. arachnoidea* especially as very close to *P. strigosa*. In proposing the species *P. glabrella*, I cited as a synonym *P. sericea* var. *glabrata* Lehm.,* following Dr. Watson. Dr. Wolf points out that the specimen on which this variety was based belongs to a form of *P. plattensis*. From the characterization I believe that Dr. Wolf is correct, and that the synonym should be eliminated.

NEW YORK BOTANICAL GARDEN.

*Hook. Fl. Bor.-Am. 1: 189. 1832.

Contributions to the history and bibliography of the roselle

P. J. Wester

The date of the earliest introduction of the roselle, *Hibiscus Sabdariffa* L., into the United States is unknown. It was introduced from Australia into California fifteen years ago and seems to have been introduced into Florida somewhat earlier, but at what date and by whom is obscure. Not until the last few years has the plant, in the United States, received the attention it deserves, but it is now, as its useful qualities become better known, being planted more widely. For several years the writer has been engaged in the study of the roselle and its improvement, in the course of which work it was thought desirable to trace its early history. The following notes have been prepared as a result of this effort. The writer wishes to acknowledge his indebtedness to Miss Audrey Goss for the translation of the description of the roselle plant by Clusius and other quotations from works published in Latin.

The earliest reference to the roselle, accompanied by a woodcut, of which FIGURE 1 is a reproduction, that has come to the attention of the writer, occurs in Stirpium Historia, by the Flemish botanist M. de L'Obel, published in 1576. That the plant was then new to him may be inferred not only from the fact that he does not mention the plant in his Stirpium Adversaria Nova, published four years before, but from his expression, "Huc spectat perelegans & nova planta quam quidam Sabdariffam vocãt." The species was probably brought westward from India by the Mohammedans, who several centuries before this date invaded India. That the plant was from the first known by the name Sabdariffa, a Turkish word according to Drury,* lends color to this belief. Neither L'Obel nor other early authors that have come to the attention of the writer, refer to the circumstances under which the plant was introduced into Europe.

Dalechamps figures two woodcuts in his work † under the

* Drury, H. Useful Plants of India 252. 1858.

† Dalechamps, J. Historia Generalis Plantarum 595. 1587.

name Sabdariffa; one, a reversed cut from the one in L'Obel's work named "Sabdariffa, Lobellij," is the roselle plant, the other, 'Sabdariffa, Alia," is very evidently another species, as the de-

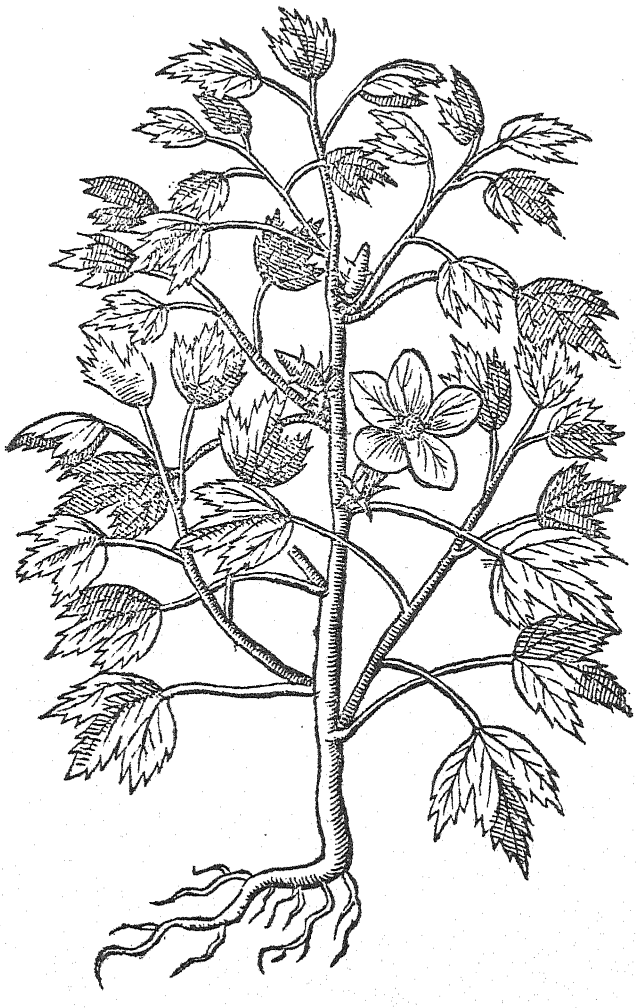

FIGURE 1. Roselle plant as figured by L'Obel in Stirpium Historia, 1576.

scription also indicates. Clusius in Rariorum Plantarum Historia, published 1601, p. xxvi, has a remarkably good woodcut of the plant accompanied with the following description:

"*Sabdariffa:* There should be a common description of this most elegant plant, as I have seen that its history has, up till

FIGURE 2. Reproduction of the roselle plant as illustrated by Clusius in Rariorum Plantarum Historia, 1601.

recently only been lightly sketched and as there was no reliable illustration of it I have concluded that it would be worth while to

describe it a little more accurately and present to the reader a clearer and better illustration which I have taken from Jacob Plateau." (FIGURE 2.)

"It has an upright stem, striped, purplish, and is two or three cubits high or even higher if it is planted in rich soil in the garden, if it is planted in pots it is much shorter. The leaves grow around the stem from the bottom not in a regular series, but sparsely scattered here and there; the lower ones are somewhat serrate, but not laciniate, those in the middle are divided into five, similar to the leaves of the *Cannabinus*, and at the very top it ends in a sort of spike of little buds and narrow leaves. A single, slightly spiny calyx is inserted in each axil, from which grows a flower with five large petals, pale white with the tips dyed a deep, blackish purple, radiating over the petals, the center of the flower is occupied as in the *Althaea* called bladder-wort or *Hypecoum Matthioli*, by many stamens with yellow apices and a white style branched above the middle; the flowers are followed very quickly by short, spiny acuminate, pentagonal heads, containing a seed almost like that of the *Stramonium;* the root consists of a great number of whitish fibers, but it is not perennial, but must be sown anew every year, and with us at least it seldom seeds, for it begins to bloom late, about the end of August or the beginning of September (Netherlands) and as it does not bear cold at all well, the first frost kills it. It seems to like the rays of the morning sun and frequent watering. The seed was first sent to us from Italy under the name of Sabdarifa (I do not know whether it was given this name in its native habitat) then from Spain under the genus *Malva, Indica elegans;* there is scarcely any doubt that it is to be referred to the *Malva* and to the class *Alceae*, therefore I have given it the name *Alcea Americana*."

While Clusius does not state this expressly we may infer from the name he gave the roselle that he considered the species to be of American origin.*

Bauhin † referred to it a few years later as "*Alcea indica magno flore*." J. Gerarde describes the plant thus in his Herball, 1636, p. 936, under the name *Sabdarifa*, Thorny Mallow.

*Why Pickering, in Chronological History of Plants, 1879, associated with the roselle the plant described by Hernandez as quauhxocotl, in Nova Plantarum Animalum et Mineralium Mexicanorum Historia, is not clear, as not only is Hernandez's description that of another plant but he closes the description by saying that "The leaves of Alcea Americana (the roselle) are similar" (to this plant), with which plant Hernandez evidently was familiar from Spain.

† Bauhin, C. Pinax Theatri Botanici 317. 1623.

"Thorn mallow riseth up with an upright stalk of two cubits high dividing itself into divers branches, whereupon are placed leaves deeply cut to the middle rib and likewise snipt about the edges like a saw: in taste like the sorrel, the floures for the most part thrust forth of the trunk or body of the small stalke, compact of five small leaves of a yellowish colour; the middle part whereof is of a purple tending to rednesse; the huske or cod wherein the floure doth stand is set or armed with sharpe thornes: the root is small, single and impatient of our cold climate, insomuch that when I had with great industry nourished up some from the seed and kept them unto the midst of May notwithstanding one cold night chancing among many hath destroied them all."

The woodcut accompanying this description is a reproduction of that used by Clusius in the work referred to. The writer has not had access to the first edition of the Herball issued in 1597 and therefore can not say if the description of the roselle and the illustration accompanying it were contained there. Clusius does not refer to Gerarde, but Bauhin, in Pinax Theatri Botanici, published twelve years earlier than the second editon of Gerarde's Herball cited, does, showing that the plant was mentioned in the first edition. Aiton says that it was cultivated by Gerarde in England, 1596,* additional evidence that the first edition of the Herball contained reference to the roselle. The lack of reference to Gerarde by Clusius is not proof that he was not acquainted with his work, for omissions of this character are habitual with him.†

J. Bauhin says ‡ that he saw the plant flowering in September, 1595, at Basel (Switzerland). He says further that "Rauwolfius says that it is known among the Arabs as *Lubie Endigi*, that is, *Phaseolus indicus*, and thinks it is the *Trionum* of Theophrastus —but I think this plant (roselle) was unknown to the ancients." However correct the conclusion of Bauhin was in regard to synonymy of *Trionum* and *Lubie Endigi*, it is evident from the description and woodcut of this plant by Rauwolfius that he had in mind another plant, probably the okra.

*Aiton, W. Hort. Kew. 4: 227. 1812.

†Since writing the above I have had access to the first edition of Gerarde's Herball. The description of the roselle plant there is substantially the same as the one quoted; the woodcut accompanying it is a reproduction of the figure by L'Obel in Stirpium Historia, reversed.

‡Bauhin, J. Historia Plantarum 2: 960. 1651.

The authors consulted from this date or earlier do not speak directly of the native habitat of the roselle, not is any mention made of the use of any part of the plant, although its acid properties are recognized already by L'Obel. The culinary and medicinal uses of the plant are first mentioned by Bontius, who says that, "The leaves have a sour taste and are used as a relish with fat and glutinous foods. It is cooling; the Malayans, Bengalese and other Moors use it as a vegetable; . . . in high fevers and delirium it is also used."* It is by Bontius described as growing in Java and the surrounding islands. The roselle is alleged to be described and figured in Hortus Malabaricus **6**: 75. *pl. 44*. 1686, under the name of *Narinam-Poulli*, but a careful examination of the lengthy description, aided by the woodcut of the plant, shows that this description is undoubtedly that of some other plant. Hermann † mentions the use of the leaves of the roselle for spinach and is the first to speak of its cultivation for fiber.

Not until the beginning of the eighteenth century is the roselle reliably reported from the Western Hemisphere and then in cultivation; notwithstanding the contention of some authors it may therefore be safely assumed that the species is indigenous to the tropics of the Old World, probably India and Malaysia. From America the roselle was earliest reported from Jamaica by Sloane,‡ who says, "It is planted in most gardens in this Island. The capsular leaves are made use of for making Tarts, Gellies, and Wine, to be used in fevers and hot distempers, to allay heat and quench thirst." It would thus appear that the culinary use of the calyces was first recognized in Jamaica.

There is considerable synonymy of the roselle among the pre-Linnean authors using the polynomial nomenclature of the period. The name Sabdariffa, as already shown, was connected with this plant from the time of its introduction into Europe but was also applied to what are undoubtedly other species. It is sometimes spelled Sabdarifa. Many of the passages referring to the roselle in the botanical literature of this period are merely

* Bontius, J. Historia Naturalis 113. 1658.

† Hermann, P. Catalogus Horti Academici Lugduno-Batavi. 1687.

‡ Sloane, H. Natural History of Jamaica 1: 224. 1707.

quotations from other authors who again quoted earlier ones, not always correctly; some of the illustrations accompanying these descriptions have little resemblance to the roselle plant and would seem to have been fancied by the author lacking living specimens for description.

The earliest references to the white-fruited variety of roselle was made by Hughes * from Barbados in 1750, which may indicate that this variety has originated in America. Already in his days the calyces were used in wine-making there. As late as 1768, P. Miller, in Dictionary of Gardening, ed. viii, describes the roselle from the West Indies as *Hibiscus gossypifolius*, including both varieties mentioned by Hughes, and describes another species from India under the name *Hibiscus Sabdariffa*. Like certain other contemporaries, Miller thought that the West Indies were the native habitat of the roselle. Cavanilles described the white-fruited variety of roselle as a separate species, *Hibiscus digitatus*,† but this has been repudiated by later botanists.

Its utility for commercial purposes seems not to have been recognized until the middle of the past century when the roselle was first recognized as a fiber plant of value. J. F. Royle in Fibrous Plants of India, published 1855, p. 260, says, speaking of the roselle and two other species of *Hibiscus:* "The dietical use of these species has been mentioned to show that if cultivated on account of their fiber, they would also be useful for other purposes." Taken literally this would indicate that the roselle was not even then generally cultivated, notwithstanding that it was known more than 150 years earlier that it yielded fiber. That it had attracted but little attention scarcely a third of a century ago, is shown by the fact that it was not included by A. De Candolle in his Origin of Cultivated Plants, published in 1882.

While the value of the roselle for culinary purposes was recognized much earlier, as has been shown on another page, only recently has its commercial worth in this respect begun to be appreciated. The cultivation of the roselle on an extensive scale for this purpose was first attempted in Australia, and Semler reports two large preserving factories for the manufacture of

* Hughes, G. Natural History of Barbados 204. 1750.

† Cavanilles, A. J. Monadelphiae Classis Dissertationes Decem 151. 1790.

jam as being in operation in Queensland, 1892,* and according to Shinn † roselle jam is shipped from Queensland to Europe in large quantities. The more recent contributions to the knowledge of the roselle are an article by G. Watt in Dictionary of the Economic Products of India, 1885, and Farmer's Bulletin No. 307, Roselle: Its Culture and Uses, U. S. Department of Agriculture, 1907, by the writer. See also Report of the Florida State Horticultural Society, 1908, and the Reports of the Hawaii Agricultural Experiment Station, 1907 and 1909. The description of the Victor variety of William A. Taylor, in the Yearbook, 1909, is accompanied by an excellent illustration of the fruit of this variety in natural colors.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

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* Semler, H. Die tropische Agrikultur 391. 1892.
† Calif. Agr. Exp. Sta. Rep. 1896–1897: 382.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1907–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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BULLETIN

OF THE

TORREY BOTANICAL CLUB

MARCH, 1911

The ferns and flowering plants of Nantucket—VII

EUGENE P. BICKNELL

ROSACEAE

THE BLACKBERRIES

Blackberries are abundant on Nantucket, growing nearly everywhere except in the salt marshes. Low or trailing forms predominate, but the taller kinds are only less common and widespread. The visiting botanist who may be interested in blackberries will notice at once among some of the common eastern species others of less familiar aspect, and will shortly discover that the group as a whole embraces a numerous and variously interrelated series of forms, which give a problem in classification not easily solved. An attempt to understand these plants will find little or no help in published works, nor is the obscurity that invests them at all illuminated by the numerous descriptions of alleged new species, which of late years have found their way into print. In a recent paper* I have suggested that the solution of this blackberry problem is to be sought, not in a recourse to a large and dubious number of closely related new forms, but rather in a clear reading of the broad lines marked out by a comparatively few primary species, most of which were long ago well defined. It would seem to have eventuated in nature that each one of these primary species ranges structurally through a very wide orbit of variation, and that, in addition, all are involved in actual organic entanglement through a process of intercrossing,

*Bull. Torrey Club **37**: 393–403. 8 S 1910.

[The BULLETIN for February, 1911 (**38**: 45–102) was issued 7 Mr 1911.]

which, where encouraged by favoring conditions, has produced a highly complicated association of individualized forms.

Nowhere, perhaps, are to be found conditions more apt for marked variation and free hybridization in this group of plants than on Nantucket. Here, on an outpost island, removed from all direct influence of their general tribe, blackberries have for centuries grown and spread, acting and interacting under conditions of isolation and of group compression which could scarcely have failed to register some profound result in their structure and general economy. And scarcely in less degree must another influence have operated with modifying force in their local status. Within historic times the island has undergone almost complete deforestation. Subjected to a derangement so fundamental in their environment, already closely drawn, this insular group of blackberries must have experienced, superadded to their condition of physical isolation, a wholly new set of artificial conditions requiring some general readjustment of organic contacts among the species throughout the group.

It may be readily conceived that in the case of annual plants, or of species perennial by their roots alone, the effect of an environment so specialized and so modified, even though continued for a long period of time, might wholly fail to break through the organic individuality of old-time species, and thus fail of any appreciable expression. But it may be no less readily conceived that in the case of a group of plants such as the blackberries, perennial not alone by the simple root but by suckers as well, and in many cases by proliferous and rooting stems, a similar environment might well force a response in their morphology, which, once elicited, would be effectually shut off from escape. Variations of whatever degree in species so constituted would find instant protection and ready perpetuation in the mere activities of natural growth. An accidental hybrid multiplied by vegetative process alone into an established colony would be founded in the strong potency of becoming finally widespread. And it is not difficult to believe that the establishment of such a new form by vegetative reproduction would allow whatsoever period of time might be needed to reestablish any impaired capacity of reproduction by seed. It is worthy of note that many of these blackberries,

which appear to be clearly of hybrid origin, are not less fertile than their parent species. And here the possibilities in regard to compound or even decomposed hybrids opens widely on the view.

The treatment of the Nantucket blackberries which has been adopted in this paper, is allowed to rest frankly on the considerations here expressed in outline. The sufficient proof that many of our distinct appearing blackberries or, indeed, that any of them are of hybrid origin is yet to be forthcoming. The evidence relied upon in so regarding them is wholly circumstantial. And therefore, however well satisfied I may personally be of the hybrid origin of many of the plants here described, it must be understood that a mark of interrogation should apply to every one of them, first, as to its actual hybrid character and, second, as to whether if a hybrid the factors in its parentage have been correctly suggested.

The study of the blackberries of Nantucket, far from being completed, must be regarded as only just begun. With each succeeding visit to the island I have more acutely realized that a series of fleeting visits, wherein the entire flora was under observation, was wholly inadequate for an effective study of so exacting and recondite a problem as that which the group presents.

A series of specimens representing all of the hybrid blackberries herein described has been deposited in the herbarium of the New York Botanical Garden.

RUBUS STRIGOSUS Michx.

Abundant on Coskaty, and occasional in thickets on the eastern side of the island: Saul's hills; Rattlesnake Bank, Quaise, Polpis, Pocomo, and Squam. In full flower as late as June 20, 1910.

*RUBUS OCCIDENTALIS L.

Thickets at Shawaukemmo Spring, where it fruits abundantly and appears to be native; occasional by street sides and fence rows in the town and suburbs, appearing as if introduced.

RUBUS TRIFLORUS Richards.

Reported as a Nantucket plant in Mrs. Owen's catalogue, on the authority of Mr. Dame, from "bog near Sancoty" [Sankaty].

*RUBUS ALLEGHENIENSIS Porter.

Thickets at Watt's Run, a copiously glandular and pubescent form with rather short, closely flowered racemes, and flowers 2–3 cm. broad; in full flower June 15, 1908. A less glandular and less pubescent form at Quaise.

The Nantucket plant might be more particularly defined as the *R. nigrobaccus* of Bailey, if any distinction is to be made between this and *R. allegheniensis*.

RUBUS ARGUTUS Link.

R. floricomus Bld.

R. Andrewsianus Bld.

Frequent and locally common, but not generally distributed, occurring mainly on the eastern side of the island. In full flower June 17–28, 1910; fruit ripe Aug. 12, 1906. The tallest and finest-fruited blackberry of the island, becoming over six feet in height, although often much lower and sometimes with widely decurved branches. It varies greatly according to its situation, whether in dry or moist soil or in sun or shade; leaflets from suborbicular with cordate base to lanceolate-oblong and narrowly cuneate, sharp-serrulate to coarsely cut-serrate, densely velvety-canescent to cinereous-pubescent beneath, the lateral pair slender-stalked or subsessile; pedicels naked or well armed even on different parts of the same plant.

I am indebted to Dr. B. L. Robinson for a carefully executed copy of an original tracing by Dr. J. M. Greenman of the type specimen of *Rubus argutus* Link, preserved in the Berlin herbarium. This tracing is so closely a counterpart to specimens of the plant here discussed, from Nantucket and Long Island, that their identity with Link's species cannot be a matter of any doubt.

* RUBUS FRONDOSUS Bigelow.

Common in thickets and open grounds and passing readily from one to another form within marked extremes. The leaflets may be short and broad or narrow and tapering, and also vary greatly in marginal pattern and pubescence, from somewhat evenly dentate-serrate to irregularly laciniate and from loosely short-pubescent to almost villous beneath. In open sandy fields

the plant is sometimes quite prostrate, in better soils erect and recurving. Occasionally in damp shaded thickets, as on Rattlesnake Bank and in Pocomo, its stems ascending through the shrubbery become reclined and long-trailing over the bushes five or six feet above the ground. Such plants are usually characterized by thin and light green, long-attenuate, narrow leaves, but they pass imperceptibly into the more stocky and pubescent broader-leaved and darker green plant of more open ground. First flowers June 8, 1908; last flowers June 26, 1910; ripe fruit August 6, 1906.

The prevailing form of this species on Nantucket is recognizable as the plant which has been described as *R. recurvans* Bld. Should it be held that this plant is sufficiently divergent to merit specific standing, the nomenclature of the several hybrids of *R. frondosus* herein described should be correspondingly modified.

* RUBUS NIGRICANS Rydb.

The prevailing form on Nantucket of this, perhaps the most widely variable of all our blackberries, is notably different from any form of the plant I have met with elsewhere. Northward, or at higher altitudes, the species seems to tend towards delicate forms, often only sparsely bristly, with narrower and glabrate, brighter green leaflets; southward in coastwise swamps, or inland, coarser forms are found with larger, duller green, more pubescent leaves, and a more pronounced development of bristly armature, which is copiously glandular-hairy throughout. Forms similar to these are found occasionally on Nantucket, but the more usual form on the island is marked, in its extreme development, by its almost non-glandular character; dark purple, more or less angled stem, armed with strong, straight, acicular prickles, which are often swollen at the base; thick and shining glabrate leaflets, mostly suborbicular and obtuse and somewhat crenate-dentate; and a bristly almost non-glandular inflorescence, the calyx lobes glabrate to tomentulose and with or without setae and glandular hairs. This plant passes on the one hand into the coarser, more pubescent form above referred to with subterete, densely bristly and glandular-haired stems and narrower, obovate-oblong, acute, serrate leaflets, and on the other hand into a re-

duced and slender, sparsely weak-prickly form with prostrate or trailing flowering stems, small leaflets, and a simple, more racemose inflorescence. This smaller plant is often strictly trifoliolate and so nearly approaches forms of *R. hispidus* that the lines of distinction between the two become much confused if not quite obliterated. The petals vary like the leaflets and may be narrowly oblong or nearly orbicular.

Certain more pronounced examples of the broad-leaved trailing plant I was at first inclined to regard as involved with *R. flagellaris*, and they may be, but further study of the specimens seems to show that they are not necessarily other than an extreme variation of *R. nigricans*. Still, should anyone choose to esteem this Nantucket plant a distinct species it would not be difficult to concur.

My observation of the entire species seems to show that the coarser, more densely bristly and more pubescent forms are developed among the rank vegetation of heavier wet soils, and that the more spiny and glabrate forms belong to soils that are damp and sandy. In dry open places occur forms, either pubescent or glabrate, which are almost non-glandular and sometimes only sparsely armed with recurved bristles or prickles. Adjoining stems arising from the same root may be variously armed, and I have a specimen collected at Woodmere, Long Island, which strikingly illustrates the great variability of the plant, an almost unarmed, loosely pubescent stem arising side by side from the same root with one densely clothed with slender bristles and gland-tipped hairs but destitute of any proper pubescence.

Just in flower and in full flower at different stations on Nantucket June 22, 1910; some ripe fruit August 9, 1906.

RUBUS HISPIDUS L.

Common and very variable. Stems densely invested with weak, retrorse, bristly hairs or armed with few or many slender, straight or decurved hard prickles, and bearing gland-tipped hairs throughout or only on the growing parts; leaves from obovate or orbicular and crenate-dentate to cuneate, very acute and cut-serrate, the inflorescence with or without bristly or gland-tipped hairs, the calyx lobes glabrate to canescent, rarely with reddish glandular hairs; occasionally 5-foliolate leaves are produced.

First flowers June 18, 1910; at other stations not yet in flower June 24, 1910.

RUBUS PROCUMBENS Muhl.

Common and very variable; many specimens are uncharacteristic and apparently involved with other species. In full flower June 15, 1908, June 19, 1910; ripe fruit August 6, 1906.

* RUBUS BAILEYANUS Britton.

Frequent or common in dry thickets and pine groves. Flowers 2.5 cm. to over 5 cm. wide, the petals commonly very broad, often orbicular and nearly 2 cm. wide, actual measurements of the largest seen being 2.6 cm. long by 1.8 cm. broad. Freshly in flower June 11, 1908.

* RUBUS ENSLENII Trat.

Common in open sandy places, even in pure sand, and in dry pine groves. Flowers equally as broad as those of *R. Baileyanus* but with narrower, oblong petals; fruit subglobose, of medium size, with rather large drupelets, somewhat insipid and watery. First flowers June 4, 1909, June 7, 1908; ripe fruit August 7, 1906. Many examples match perfectly with specimens of *R. Enslenii* in the herbarium of the New York Botanical Garden from Virginia, Georgia, and Alabama.

* RUBUS FLAGELLARIS Willd. Enum. Hort. Berol. 549. 1809.

Prostrate, the long-trailing stems and branches soft and somewhat fleshy towards the ends and rooting freely at the tips; stems terete or subterete, smooth, often purplish; prickles usually few and scattered, sometimes almost wanting, acicular, or even bristle-form on the new shoots, very short and decurved, often with thickened base on the upper stem and branches; primary leaves 3-foliolate, on rather short, glabrous, or thinly pubescent petioles, 2–5 cm. long, armed like the stem; leaflets usually dark green, often purplish, or even deep purple when young, of firm texture, thickish, often subviscid to the touch, glabrate or bearing scattered appressed hairs on the upper surface, glabrous beneath or minutely subappressed-pubescent along the veins; leaflets variable in size, commonly 4–6.5 cm. long and 3–5 cm. wide but often smaller, closely and frequently very irregularly denticulate or denticulate-serrate to more openly dentate, the teeth abruptly acuminate, usually with firm incurved points; the odd leaflets orbicular or obovate-orbicular to broadly elliptic, abruptly short-acuminate,

rounded or cuneate at base; the lateral leaflets broadly rhombic and notched or cleft on the lower margin to form a prominent rounded lobe; flowering branchlets slender, angled, thinly pubescent, sparingly armed or unarmed, the lower becoming 2 dm. long, the upper much reduced; inflorescence, when fully developed, a loose corymbose, sometimes compound cluster of mostly 2–5 slender, erect or ascending pedicels and several, usually conspicuous, unifoliate, often deeply lobed, glabrate leaves sometimes 4–6 cm. wide; pedicels mostly 3–6 cm. long, thinly loose-pubescent to glabrate, unarmed or sparingly setulose, but destitute of glandular hairs, often bearing one or more green bracts, and occasionally branched; calyx lobes broad, minutely pubescent on the outer surface, white-tomentulose within, often with foliaceous termination; flowers not usually large, spreading 2–3.5 cm.; petals oblong or broader, narrowed towards the base; fruit subglobose to ovoid, often small but becoming of good size; drupelets large, large-seeded, thinly arachnoid-pilose when young and even at maturity, rather watery and insipid or acid.

Frequent or common in open sandy places and in pure sand. In fresh flower June 15, 1910; fruit ripe August 4, 1906. Frequent on Long Island.

The trailing blackberry, *Rubus flagellaris*, well defined by Willdenow over a century ago, has ever since been lost to the recognition of botanists. Professor L. H. Bailey has told us* that the type specimens are still in existence in the Berlin herbarium. Until actual comparison has been made of these specimens with the plant here brought to notice, a doubt may fairly be entertained whether the two are actually the same, although the evidence that they are would seem to be reasonably conclusive. Willdenow's species has been a continuing mystery. Bailey, who studied the type specimens, seems to have doubted whether it was an American plant at all. A particular interest therefore attaches to this Nantucket and Long Island blackberry, if it shall now finally dispel the mystery and resolve the doubt. That the original description of Willdenow applies to this plant with really close precision might not of itself be enough to justify a conclusion. But in addition it will be found that the illustration of the type specimens, presumably from a photograph, which Bailey has supplied, † leaves little to be desired in the way of convincing

*Evolution of our native fruits, 368.

†Loc. cit., 369.

evidence. It was this illustration, in fact, which first drew my attention to Willdenow's species in this connection and when, quite unexpectedly, it first met my notice it was impossible not to give it instant acceptance as an illustration of the Nantucket plant.

The species is, of course, allied to *R. procumbens* but differs in its softer stems, more sparsely and weakly armed, with smaller prickles, darker green and more coriaceous, glabrous or glabrate, trifoliolate leaves, which are subviscid to the touch, those of the shoots with the leaflets more finely denticulate, more obovate and short-acuminate, and often cuneate at base. In its typical form it also differs conspicuously in the greatly enlarged unifoliate leaves of the inflorescence. The leaves of the season's shoots in form, color, and texture, as well as in their often purplish color, often suggest those of *R. hispidus*, although usually larger, but the cross *R. hispidus* × *procumbens*, which thus comes to mind, proves to be actually a very different plant.

* RUBUS ALLEGHENIENSIS × ARGUTUS.

Erect, recurved above, 0.5–1.5 m. high, becoming widely branched; stem purplish, more or less angled and grooved, the new shoots and often the prickles sprinkled with minute, reddish, sessile glands; prickles numerous or few, slender, 3–5 mm. long, or, on stouter plants, becoming broad-based and 10 mm. long, straight and erect, on the branches becoming retrorse but scarcely decurved; primary leaves 5-foliolate, on slender pubescent petioles 4–8 cm. long sprinkled with reddish, sessile or occasionally short-stalked glands and armed with scattered, retrorse or decurved prickles; leaflets thinly appressed-pubescent above, minutely soft-pubescent beneath, narrow, lanceolate to oblong-lanceolate or ovate-lanceolate, often long-tapering, usually the odd one and often the middle pair cordate, unevenly denticulate-serrulate, the teeth acuminate, those terminating the larger veins often larger and slightly recurved; petiolules slender, pubescent, glandular like the petioles, those of the odd leaflets 1.5–3.5 cm. long, those of the lateral pair one-third to one-half as long; leaflets of the flowering branches usually bearing stipitate glands and often somewhat cut-serrate or laciniate; inflorescence of numerous short, often closely flowered racemes, which are sessile or terminate short branchlets, naked or with a few reduced unifoliate or trifoliolate leaves below, the axis thinly short-pubescent with spreading hairs and invested with numerous minute, short-stipi-

tate, purplish glands; flowers 6–16, their pedicels glandular, short, slender, spreading or ascending, unarmed or with occasional weak prickles; sepals green, lanceolate-attenuate, pubescent and glandular to glabrate; flowers small, the petals 1–1.5 cm. long, obovoid-oblong, sometimes tinged with crimson; fruit small, ovoid or subglobose, of rather small drupelets.

Met with at only two stations on the borders of low thickets near Shawaukemmo Spring. First flowers June 4, 1909; in full flower June 11, 1908; young fruit June 26, 1910.

The form of this plant, here particularly described, is distinguished by lanceolate, tapering, sharply denticulate-serrulate leaflets and small, narrow racemes, thickly invested with short-stipitate glands, unarmed pedicels, and rather small flowers, sometimes so brightly tinged with crimson as to have the appearance of apple blossoms.

At two places on Nantucket, plants were collected which are similar to this plant in general form and leaf shape but differ in their villous-pubescent almost non-glandular inflorescence, longer pediceled flowers, and sparse armature throughout. Similar plants occur on Long Island, in which the subterete purple stems are sometimes nearly unarmed and the inflorescence may be with or without stipitate glands even on the same specimen. In this form the racemes tend to be sessile and appressed along the upper part of the stem. Other specimens from Long Island are unmistakably referable to the typical Nantucket plant, even showing a tendency to crimson tinted flowers, but often differing by broader, more acuminate, and less irregularly cut leaflets.

* RUBUS ALLEGHENIENSIS × FRONDOSUS.

Stems of the first year erect, 0.75–1.5 m. high, often bearing scattered and deciduous stalked glands, sometimes remaining erect the second year, but more often recurving and declined or even partly trailing, simple or sparingly branched, purple, smooth, often terete or subterete, sometimes very sparsely armed, but commonly bearing remote or scattered, more rarely rather numerous prickles; prickles simple often broadened only at the extreme base, erect, straight or slightly curved, mostly 4–7 mm. long; primary leaves 5-foliolate or the lower 3-foliolate, on slender petioles 6–12 cm. long; petioles thinly pubescent to villous-tomentulose, bearing either scattered or numerous stalked glands; leaflets thin and soft, pale green, appressed-pubescent on the upper surface, paler and

closely short-pubescent or velvety beneath, denticulate to irregularly dentate-serrate with acuminate or attenuate teeth, ovate to ovate-oblong or oblong-lanceolate, acuminate, the odd one often cordate, its petiolule 2–4 cm. long, the lateral pair short-stalked; flowering branchlets rather short, usually confined to the upper part of the stem, the lower branchlets stouter and leafy; inflorescence racemose or somewhat corymbose, a few of the lower flowers subtended by reduced trifoliolate or unifoliate leaves; axis and pedicels short-pubescent with spreading hairs to tomentulose, bearing few or numerous stalked glands or sometimes obscure sessile glands only; pedicels slender, ascending or spreading, often weak and flexuous when young, 1–4 cm. long, unarmed or sparsely setulose; calyx lobes thinly pubescent to somewhat villous, with or without gland-tipped hairs, apiculate to caudate; flowers small or medium-sized, petals oblong to obovate, 1–1.5 cm. long; fruit apparently rather small, ovoid-subglobose, the drupelets medium-sized.

The foregoing description is derived primarily from specimens collected on Long Island, where the plant is frequent in open woodland.

It was met with only at two stations on Nantucket; thicket near Shawaukemmo Spring, first flowers June 11, 1908, and pine scrub near the fair grounds, in full flower June 17, 1908, both examples being only obscurely glandular and otherwise atypical.

The plant is ordinarily well characterized among allied forms by lax habit, sparse armature, long-petioled thin leaves, and short, subcorymbose, mostly glandular raceme. Occasional specimens are ambiguous and very puzzling, appearing to lie midway between typical examples and forms of *R. allegheniensis* × *argutus*.

* RUBUS ALLEGHENIENSIS × PROCUMBENS.

Shoots ascending, early recurved or declined, becoming very slender and flexuous and trailing over bushes or on the ground, simple or sparingly branched; stems more or less angled, sometimes furrowed below, purplish brown to bright purple, either sparingly armed or provided with numerous prickles mixed with scattered gland-tipped bristles and glandular hairs; prickles acicular above the broadened base or often bristleform, mostly 3–5 mm. long, straight, erect or slightly retrorse, or even decurved, especially on the petioles and petiolules; primary leaves 4–10 cm. long, 5-foliolate, even the lowest rarely 3-foliolate, often numerous;

petiolules thinly pubescent with loosely spreading hairs; leaflets often dark green, somewhat shining and sparingly appressed-pubescent to glabrate above, minutely pubescent beneath, acutely and unequally dentate or dentate-serrate; the lateral veins rather numerous, becoming prominent, the odd leaflet ovate to ovate-oblong, acuminate, cordate at the base, its petiolule short-pubescent to tomentulose, 1.5–4 cm. long; middle pair of leaflets oblong or somewhat rhomboid, tapering at the apex, somewhat narrowed to an entire, inequilateral, abruptly short-contracted, often cordate base, subsessile or short-stalked; trifoliolate leaves of the flowering stems often somewhat doubly serrate-dentate or cut-lobed; inflorescence corymbose-subracemose, naked or sparingly unifoliate-bracteate, sometimes slightly compound, terminating numerous leafy branchlets 5–20 cm. long, which do not usually extend into the terminal portion of the stem; pedicels slender, erect or spreading, 2–6 cm. long, thinly pubescent to tomentulose, unarmed or sparingly setulose, with the calyx bearing delicate gland-tipped purplish hairs of unequal lengths; calyx lobes oblong to lanceolate, short-tipped or caudate; flowers often rather small, becoming 2.5 cm. wide or wider; petals broadly oblong or obovoid; fruit rather small, ovoid or subglobose, the drupelets medium-sized.

Found at one locality near Wauwinet, and a single plant in Millbrook Swamp. First flowers June 11, 1909; in full flower June 20, 1910. Frequent on Long Island. In some of its forms this plant approaches so closely to forms of *R. allegheniensis* × *frondosus* that in the present state of our knowledge confident assignment of all specimens is scarcely possible. In general it differs from *R. allegheniensis* × *frondosus* in its more prostrate and slenderly trailing habit; smaller and more slender, more numerous prickles, often mixed with gland-tipped hairs or bristles; firmer, darker green, strongly venose leaflets, which are less densely pubescent beneath and more evenly dentate with shorter teeth, the middle pair often cordate; slender and flexuous, more numerous flowering branchlets, often wanting towards the upper part of the stem; more corymbose and glandular, often naked, inflorescence of slender-pediceled flowers.

* RUBUS ARGUTUS × FRONDOSUS.

Stout, erect, recurving above, becoming widely branched the second year; stem and branches yellowish green to dull purple, rigidly flexuous, angled and sulcate, or the branches subterete,

strongly and stoutly armed; prickles numerous, even crowded, compressed, straight or strongly hooked, especially on the branches and petioles, hard and sharp, often very large, becoming over 12 mm. long, and abruptly contracted from a widely expanded base; new shoots and sometimes the prickles pubescent or even villous; primary leaves on stout, strongly armed, often villous petioles 5–8 cm. long, 5-foliolate, except the lowest; leaflets rather thin becoming coarse and venose, loosely appressed-hairy on the upper surface, closely subspreading-pubescent or even velvety beneath, ovate-oblong to elliptic or oblong-lanceolate, irregularly denticulate or dentate-serrate to cut-serrate with very acute teeth; the odd leaflet mostly rounded or subcordate at base on a petiolule 2–3 cm. long, acuminate at the apex; middle pair of leaflets subsessile or on slender petiolules 1.5 cm. long; inflorescence a leafy, villous-pubescent, subcorymbose raceme, the flowers often descending to the lower axils, its axis stoutly armed with decurved yellowish prickles; pedicels 1–3 cm. long, armed with stout, yellowish, straight or decurved prickles, or rarely unarmed, the pubescence concealing minute sessile or subsessile glands; unifoliate leaves of the inflorescence usually conspicuous, sometimes numerous, broadly elliptic to lanceolate; sepals more or less subappressed-villose, usually with narrow subfoliaceous termination; petals oblong to obovate-oblong, mostly 1–2 cm. long; fruit ovoid, medium-sized.

This plant becomes perhaps the most stoutly armed of all our blackberries, and is further characterized by its leafy villous-pubescent and strongly armed subcorymbose raceme without stalked glands. Ordinarily it has rather small flowers and is not over 1.5 m. high.

Quaise, June 9, 1909, not yet in flower; June 11, 1908, first flowers; Watt's Run, June 20, 1910, just in flower; near Sachacha. Frequent on Long Island.

* RUBUS ARGUTUS × NIGRICANS.

R. ascendens Bld.

A few plants at the border of a thicket at Tom Never's Pond, August 31, 1904, bearing some imperfectly developed fruit. An erect rather slender form of the plant with straight and spreading acicular prickles and contracted inflorescence, its axis, as well as the pedicels and calyx lobes, bearing short gland-tipped hairs, the pedicels setulose.

* RUBUS ARGUTUS × BAILEYANUS.

Shoots erect or ascending, sometimes becoming over a meter in height, finally recurved or even declined, widely branched, the branches often elongated and trailing; stems stout and angled below, terminally becoming slender and subterete, usually deep reddish purple, strongly armed throughout; prickles mostly purplish, very numerous, often crowded, becoming 7 mm. long, commonly nearly straight and slenderly very acute, the base abruptly broadened, erect or slightly retrorse, often shorter, stouter, and decurved towards the ends of the branches and on the petioles; leaves rather dark green, often shining above, and of thickish texture, those of the main stem 5-foliolate, except the lowest; the leaflets somewhat irregularly dentate-serrate, sparsely hispidulous-pubescent on the upper surface, slightly pubescent beneath; odd leaflets broadly oval to oblong-ovate or obovate-oblong, acuminate, subcordate or rounded at the base, mostly 5–6 cm. wide, 6–8 cm. long, on a petiolule 1.5–3 cm. in length; middle leaflets mostly obovoid-oblong, contracted or narrowed to a short petiolule 2–10 mm. long; flowering branchlets numerous, pubescent, leafy, the leaflets often large and more coarsely and irregularly cut than in the primary leaves; inflorescence corymbose or doubly corymbose, subtended by one or two conspicuous unifoliate leaves, the lower flowers axillary from trifoliolate leaves; pedicels firm, slender, often branched, divergent, 1–3 cm. long, pubescent but without glandular hairs, well armed with slender slightly recurved prickles; flowers conspicuous, 2.5–3.5 cm. wide, the petals broadly cuneate-obovate, sometimes broader than long; calyx lobes tomentulose-pubescent, non-glandular, commonly with narrow subfoliaceous terminations; fruit abundant, of medium size, subglobose, 1–1.5 cm. broad; drupelets of good size, very black and shining.

Low grounds below the "Cliff," several vigorous clusters; in full flower June 23, 1910. Frequent in local colonies on Long Island.

A handsome and strongly characterized blackberry, usually found growing with *R. argutus*, *R. Baileyanus*, and *R. procumbens*, the two former species appearing to be its most probable parents.

* RUBUS ARGUTUS × PROCUMBENS.

Stems rigid, woody, angled and strongly armed, or in slender forms subterete, often more or less pilose-pubescent the first year, erect or ascending and recurving, sometimes trailing, becoming

widely branched, the branches declined or trailing; prickles usually numerous, hard, rigid, slenderly very acute, straight or somewhat decurved, or some slightly recurved, commonly 3–6 mm. long, shorter and usually strongly hooked from a broader base on the petioles and petiolules; primary leaves ascending, their petioles often 7–10 cm. long, 5-foliolate except low on the stem; leaflets usually rather light green, of firm texture, lanceolate-oblong to elliptic or more or less rhombic, often narrowly cuneate at the base, acute to narrowly acuminate at the apex, frequently subconduplicate, the terminal one often broader and somewhat rounded at the base on a stalk 1–3 cm. long; lateral leaflets on petiolules 5–15 mm. long, or rarely subsessile; upper surface of the leaflets sparsely appressed-pubescent to glabrate, the lower surface appressed-puberulent with silvery hairs; marginal pattern finely and acutely serrate or serrulate or sometimes more deeply and irregularly serrate, the teeth firm and very acute; flowering branchlets pubescent, angled, mostly 5–15 cm. long; inflorescence racemose-subcorymbose, usually bearing from one to several narrow unifoliate leaves; pedicels slender, divergent, mostly 1–3 cm. long, pubescent, nonglandular, usually bearing slender, somewhat decurved prickles; calyx lobes mostly lanceolate with narrow subfoliaceous termination, pubescent, often strongly 3-nerved; flowers medium-sized to rather large, 2–3.5 cm. broad; petals oblong to obovate-oblong narrowed into a claw; fruit medium-sized of rather few juicy drupelets.

The above description is drawn mainly from specimens collected in the neighborhood of Hewlett, Long Island, and from other well established colonies in low grounds of southwestern Long Island, at Lawrence, Woodmere, and Rockville Centre. On Nantucket a solitary plant only was met with. It was strongly established and trailing widely at the foot of the railroad embankment near the second mile, where it was in flower on June 19, 1908, and June 23, 1910, and bore ripe fruit on August 7, 1906. This plant is of more prostrate habit than any example observed on Long Island, and differs further in its broader, shorter, more dentate-serrate leaflets, which are also more pubescent and of darker color.

* RUBUS ARGUTUS × FLAGELLARIS.

Erect and recurved, ascending, or becoming prostrate and trailing, often branched; stems purplish, becoming rigidly flexuous, sometimes terete but commonly angled and striate; prickles scattered or numerous, hard, short and stout from a broad base,

or more slender and 5 mm. long, straight and erect or slightly retrorse, usually broader-based, decurved, and often numerous on the petioles and flowering branchlets; primary leaves 6–10 cm. long, mostly 5-foliolate, on strongly armed, thinly pubescent petioles; leaflets thickish and dark green, often rugose, loosely appressed-pubescent on the upper surface, paler and softly short-pubescent beneath, dentate-serrate with very numerous acute teeth; odd leaflet broadly ovate to orbicular, even broader than long, rounded or cordate at base, short-acuminate, becoming 7 cm. long and 6.5 cm. broad, but often smaller, its petiolule 2.5–3.5 cm. long; middle pair mostly elliptic-obovate, rounded or somewhat narrowed towards the base, on short foot-stalks 2–10 mm. long, the basal pair broadly elliptic; flowering branchlets numerous, often erect along prostrate stems, leafy, mostly 10–20 cm. long, angled and becoming stout and stiffly flexuous, somewhat villous-tomentose, often strongly armed; their trifoliolate leaves mostly 3 or 4, on rather short petioles, succeeded above by 3–5 conspicuous, short-petioled, orbicular or suborbicular, often cordate, incised or lobed unifoliate leaves subtending the pedicels; inflorescence a short, corymbose, leafy-bracted raceme, sometimes descending by slender-pediceled axillary flowers or rudimentary corymbs to the base of the branchlet; pedicels erectly ascending, 2–4 cm. long, with the calyx villous-tomentulose, armed with rather stout, spreading or slightly decurved prickles; calyx lobes sometimes sparingly setulose, often with foliaceous prolongation; flowers full-petaled, becoming 4 cm. wide; petals oblong to obovate.

Local by roadsides and borders of thickets, especially along the Quidnet and Wauwinet roads, near Polpis and in Pocomo; Siasconset; one cluster by the roadside near the old mill. First flowers June 12, 1909; in full flower June 16–24, 1910. A noteworthy blackberry, well characterized among the semiprostrate forms by its straight, stout prickles, dark green and rugose primary leaves with broad often orbicular leaflets, leafy flowering branchlets, and suborbicular and incised unifoliate leaves of the prickly inflorescence. It is closely related to the plants herein described as *Rubus flagellaris* × *frondosus* and *Rubus Baileyanus* ×*frondosus*, and some specimens afford the suggestion that the latter may be involved in its parentage. Its stronger forms, however, seem to reveal hints of both *Rubus argutus* and *Rubus flagellaris*, and I know not to what influence other than that of the latter its orbicular denticulate leaflets may be attributed. That

it is a hybrid is indicated by its locally sporadic occurrence and its relationship to other Nantucket forms that are not less certainly of hybrid origin. Somewhat at variance with its more characteristic forms is a weaker, less spiny plant, having paler green leaves with less rounded leaflets, which though quite possibly a phase of the same cross, may include some other element.

* RUBUS FLAGELLARIS × FRONDOSUS.

I have placed here a blackberry nearly related to *R. argutus* × *flagellaris*, but differing as follows: Stems more slender and terete, sparingly if at all branched, less purplish in color, more sparsely and less strongly armed with shorter prickles; pubescence less dense and tomentulose, often scant; leaves thinner and paler green, the marginal pattern more serrate and often more coarsely cut; primary leaves smaller, the odd leaflets broadly ovate to ovate-oblong, often with somewhat narrowed base; flowering branchlets and pedicels more slender.

This plant, like the preceding, suggests close relationship to *R. Baileyanus* × *frondosus* but is obviously not the same. It appears to differ much as a hybrid of *R. frondosus* might be supposed to do where *R. flagellaris* had replaced *R. Baileyanus* as one of the parents. Certain specimens which it seems necessary to refer here appear too close to examples of *R. argutus* × *flagellaris*, but other specimens are not to be reconciled with that cross. The plant is, in fact, somewhat intermediate between *R. argutus* × *flagellaris* and *R. Baileyanus* × *frondosus*. The very close relationship of many of these plants and the essential identity of certain of their characters lend support to the probability of their being crosses of nearly related parents.

* RUBUS FRONDOSUS × NIGRICANS.

R. abbreviāns Bld.

Sometimes erect but more often recurved and spreading or partly trailing, simple or sparingly branched; stems often becoming deep red-purple, subterete to somewhat angled, densely armed, or sometimes only sparsely armed in weak plants; prickles of very unequal size, erect or slightly retrorse, straight or nearly so, acicular, the larger becoming 6 mm. long from a broadened base, the smaller diminishing into gland-tipped hairs, which usually invest the upper part of the stem; primary leaves 5-foliolate

or 3-foliolate, on loosely pubescent petioles, which are 5–10 cm. long and bear slender retrorse prickles and gland-tipped hairs; leaflets deep green, broad, rather thin, loosely appressed-pubescent on the upper surface, softly subspreading-pubescent beneath, dentate-serrate with very acute, somewhat uneven teeth; the odd leaflet ovate to obovate-orbicular, abruptly acuminate at apex, rounded or subcordate at base, becoming 5–6 cm. long by 4–5 cm. wide, its stalk 1.5–2 cm. long; middle leaflets not so broad, often somewhat rhombic, subsessile or short-stalked; inflorescence a short raceme or partial corymb terminating a broadly leafy branch bearing several trifoliolate coarsely dentate leaves and one or more conspicuous suborbicular and cordate unifoliate leaves; axis and pedicels villous-pubescent, invested with unequal spreading bristles and gland-tipped hairs; pedicels slender, 1–3 cm. long, axillary from conspicuously green, entire or 3-cleft bracts, or the lower from unifoliate leaves; sepals villous-pubescent, minutely setulose and glanduliferous; flowers of medium size, the petals sometimes sharply denticulate and fringed above with woolly hairs.

A well-established colony near Long Pond, also in Trot's Swamp. Not yet in flower June 1, 1909; first flowers June 10, 1908; passing out of bloom June 22, 1910.

* RUBUS FRONDOSUS × HISPIDUS.

R. biformispinus Bld.

Very variable; erect and 3–10 dm. high to ascending and recurved, or the flowering stems and branches declined and trailing; stems greenish purple to dull purple, simple or sparingly branched, slender, slightly angled, especially above, or terete; prickles few or numerous, variable in size and shape, mostly straight and erect, the largest becoming 4–6 mm. long, from a stout, much broadened base, and usually scattered, those of smaller size, when present, often numerous, sometimes even borne on the broadened bases of the larger ones, very unequal, many being reduced to mere swellings of the epidermis, others slender and passing into short bristles or gland-tipped hairs; primary leaves 3-foliolate or, on stouter plants, 5-foliolate; the petioles slender, becoming 10 cm. long, loosely pubescent and bearing decurved prickles and sometimes scattered gland-tipped hairs; leaflets rather deep green, often thickish and somewhat shining above, thinly appressed-pubescent on the upper surface, pubescent beneath with shorter subappressed hairs or glabrate, acutely and somewhat irregularly serrate or dentate-serrate, abruptly short-acuminate, the odd leaflet broadly ovate or ovate-oblong to elliptic or elliptic-obovate,

rounded or subcordate at base, 4.5–7 cm. long, 2.5–5 cm. wide, the stalk about 2 cm. long; middle leaflets obovate-elliptic or oblong, rounded or somewhat cuneate at base, subsessile or on petiolules sometimes 1 cm. long; flowering branchlets 8–15 cm. long, bearing below about two frequently reduced trifoliolate leaves and above a single, oval or orbicular, often cordate, unifoliate leaf; inflorescence a slender pubescent raceme, its axis sparsely setulose and bearing some slender gland-tipped hairs; pedicels slender, ascending, or spreading, 1–3 cm. long, subtended by greenish bracts or the lower axillary from the leaves, unarmed or nearly so, pubescent and bearing few or numerous gland-tipped hairs; calyx lobes softly pubescent, attenuate; flowers rather small, 1.5–2.5 cm. wide; petals oblong to obovate-oblong.

Bank of Reed Pond, June 18, 1910, in full flower, erect-ascending and partly trailing forms; Tom Never's Pond in low thicket, erect form; not yet in flower June 13, 1908, in full flower June 24, 1910. On Long Island I have collected a similar erect form from a single colony near Jamaica.

Widely different aspects are presented by the erect and the partly trailing states of this plant, and but for their obvious intergradation two different crosses might be supposed. In the erect forms the racemes are sometimes almost without glandular hairs and are small and somewhat appressed along the upper part of the stem. On the spreading forms the larger racemes terminate conspicuously leafy branchlets, and the pedicels are often clothed with gland-tipped hairs, sometimes twice the length of the pubescence.

* RUBUS FRONDOSUS×PROCUMBENS.

R. multispinus Bld.

At several stations. In full flower June 18, 1908; ripe fruit August 4, 1906, September 20, 1899.

Stems commonly more slender and trailing than in *Rubus argutus×procumbens*, armed with fewer, shorter and broader-based, more hooked prickles; leaves more pubescent, more ovate and long-acuminate, the marginal pattern more coarsely serrate; inflorescence more leafy-bracted and corymbose, with longer, more erect pedicels.

* RUBUS BAILEYANUS×FRONDOSUS.

Erect-recurving, ascending, or prostrate and trailing, simple

or widely branched; stems dull green to deep purplish brown, usually thinly pubescent the first year, angled to subterete; prickles rather numerous, short and strong, 2–4 mm. long, mostly straight and somewhat retrorse on the season's shoot, becoming uncinate on the flowering stems and branches and, especially, on the somewhat villous-pubescent petioles; primary leaves rather light dull green above, paler beneath, 5-foliolate or 3-foliolate, the petioles mostly 5–8 cm. long; leaflets thinly subappressed-villous on the upper surface, softly subspreading short-pubescent beneath, ciliolate, denticulate-serrulate and frequently also irregularly somewhat cut-lobed; odd leaflet broadly ovate-oblong to obovate, mostly 5–8 cm. long and 3–5 cm. wide, abruptly short-acuminate, rounded at the base, its petiolule 1.5–2.5 cm. long; lateral leaflets obovate- or elliptic-oblong, often rhombic, narrowed to the base, and tapering to an acuminate apex, sessile or nearly so, the lower pair short and deflexed; flowering branchlets short, often numerous and approximate, somewhat villous with a cinereous pubescence, bearing 3–4 trifoliolate leaves and above them one or more unifoliate leaves in the corymbiform raceme; pedicels 1–4 cm. long, villous-tomentulose, armed with short straight prickles; calyx lobes ovate-oblong, apiculate to subfoliaceous-acuminate, densely pubescent on the outer surface, white-flocculent within; petals conspicuous, broadly oblong to obovate-orbicular, sometimes 2 cm. long, the flowers 2.5–3.5 cm. wide; fruit ovoid-oblong, of good size, becoming 2.5 cm. long, pulpy but rather large-seeded, of indifferent flavor.

Common; first flowers June 8, 1908, June 12, 1909; passing out of bloom June 26, 1910. Fruit ripe August 2, 1906.

A characteristic blackberry of Nantucket, growing in dry or damp sandy soil about the borders of thickets or in open situations. It bears the aspect of an established species and may, indeed, be a factor in some of the crosses that have been ascribed to other parentage. If of hybrid origin it seems nevertheless to have acquired a detached and independent existence and is, perhaps, less often found in close association with its supposed parents than apart from them. Evidence of its origin as a cross may be deduced from its localized habitat, its intermediate character between *Rubus frondosus* and *Rubus Baileyanus* or *Rubus procumbens*, and the fluctuations of its variable forms towards one or the other of these species. Furthermore, on Long Island, forms occur which although not identical with the Nantucket plant are yet so similar to it that any fundamental difference between them

is not to be supposed. Such Long Island plants are of casual occurrence only and are quite certainly hybrids, apparently crosses of different local forms of the same parents that have produced the Nantucket plant. The Maine plant, which has been described as *Rubus arenicolus* Bld., is again similar to but not identical with the Nantucket plant, forms of which, however, approach it very closely.

* RUBUS ENSLENII×FRONDOSUS.

Erect and recurved, or ascending and reclined; stems simple or sparingly long-branched, purplish tinged, rather soft and becoming somewhat wrinkled-striate when dry, sparsely armed with short, slightly retrorse weak bristles, or slender and nearly unarmed, or again stouter and bearing numerous bristles below and occasionally stronger prickles; leaves rather small on slender, unarmed or nearly unarmed petioles, 3-foliolate or 5-foliolate; leaflets rather light green, ovate-oblong, or rhombic, acute or acuminate at the apex, rounded or narrowed at the base, rather coarsely and irregularly dentate or dentate-serrate, sparsely appressed-pubescent on the upper surface, softly and finely pubescent beneath, the lateral pair sessile or very short-stalked; inflorescence rather few-flowered, subcorymbose on short leafy branchlets, which are softly subappressed-pubescent, glandless and unarmed; pedicels very slender, even flexuous, 1–3 cm. long, the lowest axillary from one or two trifoliolate leaves, the one or two next above subtended by unifoliate leaves; sepals oval-oblong, blunt-apiculate to subfoliaceous-attenuate, thinly or sometimes softly subappressed-pubescent, casually with a few very short gland-tipped hairs; flowers apparently medium-sized; fruit rather small and seedy.

The description refers to plants collected on the Hempstead Plains, Long Island, which are somewhat intermediate between *R. frondosus* and *R. Enslenii*, but are not fully mature and have probably allowed only a very imperfect definition of the hybrid. A plant collected on Nantucket, near Shimmo farm, June 7, 1908, not yet in flower, seems to belong here but differs from the Long Island plant in its stiffer, more woody stem, larger and stronger prickles, looser pubescence, and larger but narrower, more coarsely cut leaflets. Another Nantucket plant, which may well be a form of this cross, occurs about the borders of thickets in dry exposed places. It is often erect or nearly so and differs from the Long Island plant in its more numerous, stouter prickles, orbicular or

obovate finely dentate-serrate leaflets of the primary leaves, and less slender pedicels usually armed with scattered and slightly decurved prickles.

* R. HISPIDUS × NIGRICANS.

I place here a plant collected in Trot's Swamp, June 10, 1908, not yet in flower, which is neither *R. hispidus* nor *R. nigricans*, although combining characters of both and growing with them. The stems are rather densely bristly-prickly with some interspersed gland-tipped hairs on the growing parts; the leaves are mainly trifoliolate, with broad rounded leaflets, which are minutely pubescent on the veins beneath and crenate-dentate to somewhat crenate-lobed; the inflorescence, not fully developed, is a raceme, the pedicels subtended by conspicuous greenish bracts, the pedicels and calyx bearing some slender setulae and gland-tipped hairs. Some of the reddened persistent leaves of the preceding season are indistinguishable from similarly persistent leaves of *R. hispidus*, and the racemose inflorescence and slenderly prolonged flowering stems seem to belong to that species; on the other hand the immature, suberect and angled new stems, some of the leaves, and the bracted inflorescence are much more nearly those of *R. nigricans*.

* RUBUS HISPIDUS × PROCUMBENS.

Shoots erect or ascending, the flowering stems prostrate and trailing, sometimes greatly elongated; stems greenish to dull purple, simple, slender, terete; prickles often bright red-purple, either few or numerous, straight, erect or slightly retrorse, acicular, often weak, 1–5 mm. long, sometimes stouter and decurved from a broader base; primary leaves either 3-foliolate or 5-foliolate, on slender, ascending, thinly pubescent or glabrate petioles 3–10 cm. long, armed like the stem; leaflets of firm texture, rather dark green, somewhat shining above, paler beneath, sparsely appressed-pubescent on the upper surface, minutely pubescent beneath or glabrate except on the primary veins; odd leaflet ovate or elliptic to obovate, acute or short-acuminate, rounded or subcordate at base, its petiolule 1–2 cm. long, the middle leaflets on very short stalks; paired leaflets of trifoliolate leaves mostly broadly rhomboid and usually notched or cleft to form a prominent basal lobe; flowering branchlets slender, pubescent, unarmed, or with a few weak prickles, often zigzag, the largest 2.5 dm. long, commonly bearing 2–4 rather distant trifoliolate leaves and one to several

unifoliate leaves in the inflorescence, the leaflets elliptic to obovate-oblong or cuneate-obovate, blunt or acute, serrate to unequally cut-serrate; inflorescence varying from a short terminal subcorymbose cluster of a few flowers to a loose and elongated leafy raceme; pedicels slender, rather densely pubescent, unarmed or sparsely slender-setulose, occasionally with an obscure glandular hair; calyx lobes thinly to rather densely subappressed-pubescent, non-glandular and unarmed; petals oblong to obovate-oblong, often small but becoming 10 mm. long, sometimes pinkish tinged.

Bank at Reed Pond, June 18, 1910, just in flower: season's shoots erect, 7 dm. high; flowering stems prostrate and long-trailing; leaves firm and deep green, shining above; inflorescence an elongated leafy raceme.

This seems to be an exceedingly variable cross. Certain specimens collected on Long Island are scarcely to be distinguished from examples of *R. vermontanus* Bld., although other specimens distributed as *R. vermontanus* are clearly different and probably represent hybrids of *R. hispidus* with *R. canadensis*.

* RUBUS ENSLENII×HISPIDUS.

Low, 3–6 dm. high, erect, often recurving above, or the flowering stems sometimes declined or even prostrate and trailing, usually unbranched; stems slender, terete or slightly angled, greenish to brownish purple; prickles weak and bristleform, short, 1–3 mm. long, numerous or few or sometimes almost wanting, straight and erect or slightly decurved; primary leaves 3-foliolate or 5-foliolate, on slender, ascending, loosely pubescent and weakly armed petioles 4–6 cm. long, light green and thinly appressed-pubescent to glabrate on the upper surface, paler beneath and minutely subappressed soft-pubescent, at least on the veins; leaflets elliptic-obovate to narrowly obovate-oblong, or the pairs oblanceolate, narrowed or contracted to the acuminate or tapering apex, gradually narrowed towards the mostly entire base, rather finely serrate above or denticulate-serrate or sometimes incised; the odd leaflet mostly 5–7 cm. long, 1.5–3.5 cm. wide, on a petiolule 5–10 cm. long; flowering branchlets numerous, slender, mostly 6–12 cm. long, pubescent, unarmed, their trifoliolate leaves rather small and short-petioled, often spreading, the leaflets elliptic to obovate-oblong and more or less rhombic, acute or acuminate at the apex, mostly narrowed towards the base, serrate or somewhat cut-serrate, varying to cuneate, and somewhat crenate-dentate; inflorescence a short pubescent raceme of close, slender, finally widely spreading pedicels, subtended by greenish bracts, or the

lower by unifoliate or trifoliolate leaves; pedicels and calyx subtomentulose, either unarmed or sparsely setulose, usually bearing short gland-tipped hairs; calyx lobes ovate, green-apiculate; flowers rather small, the petals narrowly oblong to obovate, 0.75–1.25 cm. long; fruit subglobose, 1–1.5 cm. long and wide, drupelets large, becoming 5 mm. in diameter, red or tardily black, but quite edible while red.

A very local plant of low grounds on Long Island, beginning to flower in the first and second weeks of June, the fruit ripening about the middle of August. On Nantucket a single plant was collected in sandy low ground below the "Cliff," bearing unripe fruit on August 4, 1906. This, while closely similar to Long Island specimens, differs in its smaller primary leaves with shorter more abruptly acuminate and more coarsely dentate-serrate leaflets, the leaflets of the flowering stems cuneate-obovate and crenate.

In habit and character this blackberry stands out rather notably from any other known to me. Its distinctive appearance might seem to give it standing as a valid species, but so it is with many another blackberry hybrid; and the very local occurrence of this plant on Long Island and the discovery of only a solitary individual on Nantucket would scarcely lend support to any other view than that it is of hybrid origin. Even so I am not at all assured that its parents have been correctly surmised. Actually the plant seems to bear more the suggestion of *Rubus nigricans* than of either of the species suggested as its progenitors, yet I have never found it in association with this species as I have with the others, and, furthermore, there seems to be no unknown cross of *Rubus nigricans* to which it might be referred, unless some one of these crosses has been misinterpreted.

* RUBUS FLAGELLARIS × HISPIDUS.

Prostrate and long-trailing or the new shoots ascending, often widely branched and rooting at the tips; stems slender, terete, becoming purplish or bright purple, armed with scattered or numerous, very slender, straight, and erect or slightly retrorse bristles, which are occasionally intermixed with gland-tipped hairs towards the base of the stem and sometimes pass into short decurved prickles on the older stems and branches; primary leaves 3-foliolate or 5-foliolate on slender glabrate petioles 4–9 cm. long, naked or armed with acicular, retrorse prickles; leaves firm and

membranous, dull green and sparsely subappressed-hirsutulous on the upper surface, paler beneath and glabrous or obscurely pubescent along the veins, the primary veins few with broad interspaces; leaflets broad, 3–6.5 cm. wide, 4–6 cm. long, the odd one often wider than long, abruptly contracted to a short, often curved acumination, broadly rounded or subcordate at the base; middle pair of leaflets similar but inequilateral, all more or less distinctly crenate-lobed, the lobes dentate with erect, uneven, acuminate teeth; flowering branchlets slender, 5–15 cm. long, glabrous, unarmed or sometimes sparingly setulose, often leafy towards the base and in the inflorescence and having an elongated naked interval, leaves trifoliolate, on slender, glabrous or thinly pubescent petioles 2–4 cm. long, usually weakly setulose; leaflets on the flowering branches often purple, small, mostly ovate or obovate and rhombic, the odd one often cuneate, on a very slender stalk 5–10 mm. long, firm and membranous, narrowly cleft into numerous close, acutely denticulate lobes, or even subpalmatisect, the margins often crisped; inflorescence a loose subcorymbose raceme of slender-pediceled flowers, the lower subtended by one or more trifoliolate leaves, and one or all of the others by small unifoliate leaves; pedicels very slender, 1–4 mm. or even 6 mm. long, glabrous or obscurely puberulent, unarmed or bearing weak purplish bristles and often also minute, scattered, sessile or short-stalked, purplish glands; calyx lobes glabrous to puberulent, canescent-tomentulose within, usually caudate or with foliaceous termination; flowers often small; petals oblong, 0.75–1.5 cm. long; fruit apparently rather small and seedy.

In open sandy places, sometimes in pure white sand. South of the town, June 10, 1909, not yet in bloom; Gibbs' Pond, June 18, 1908, just in flower; Quidnet, June 20, 1910, just in flower; Beechwood farm, June 26, 1910, just in flower; Gibbs' Pond, August 7, 1906, ripe fruit.

A very distinct appearing blackberry and perhaps exclusively a Nantucket plant. I have seen nothing like it from anywhere else. While some of its phases seem to point to close relationship with *Rubus flagellaris*, suggestions of *Rubus hispidus* are not to be overlooked, and I have found the three plants growing together. It is therefore here proposed as a hybrid, but I am even less satisfied than in certain other cases as to its parentage or even that it may not be a valid species.

* RUBUS BAILEYANUS × PROCUMBENS.

R. procumbens var. *roribaccus* Bailey.

R. roribaccus Rydb.

This plant, as I understand it, although subject to much variation, is stouter and more copiously armed throughout than either *R. Baileyanus* or *R. procumbens*, and has ascending early shoots which become long-trailing and much branched. It is further and especially characterized by 5-foliolate primary leaves, on strongly armed petioles, with large, coarsely and acutely doubly dentate or incised, thinly pubescent leaflets; the terminal one very broad, even broader than long and sometimes 9 cm. wide; the middle pair often on slender petiolules 5–10 mm. long; the inflorescence is a loose corymbiform raceme of 3–7 flowers, on elongated and erect pedicels becoming 6–8 cm. long; the pedicels are often copiously armed, frequently invested with gland-tipped hairs, and subtended by very large unifoliate often lobed leaves; the flowers are smaller than in *R. Baileyanus*, with narrower petals, the sepals often setulose and foliaceous.

Met with at only two stations on Nantucket: dry sloping field southwest of Millbrook Swamp, June 9, 1908, not yet in flower, and along the railroad about the second mile, June 23, 1910, passing out of bloom. In specimens from both of these stations the inflorescence is less conspicuously leafy than certain forms collected on Long Island, in which the unifoliate leaves are sometimes 6–8.5 cm. broad.

* RUBUS ENSLENII × PROCUMBENS.

R. geophilus Bld., in part.

Prostrate and long-trailing, often with elongated branches, the new shoots sometimes ascending; stems slender, terete, soft, weakly armed with very small scattered prickles or almost unarmed; prickles very short, rather broad-based, mostly retrorse or decurved; primary leaves 5-foliolate or some 3-foliolate, on slender, thinly pubescent, sparsely armed petioles 3–5 cm. long; leaflets rather thin, dark green and sparsely appressed-pubescent on the upper surface, paler and minutely subappressed-pubescent to glabrate beneath, acutely serrate to dentate-serrate, often with irregularly cut teeth; odd leaflet rhombic-ovate to ovate-oblong, rounded or subcordate to subcuneate at base, on a stalk 0.5–2 cm. long, attenuate or acuminate at apex, sometimes cleft below to form two basal lobes, or not seldom parted bilaterally into a distinct pair of accessory leaflets, making the leaf quasi-pinnate and

7-foliolate; middle pair of leaflets mostly narrowed and entire towards the base, often rhombic-lanceolate and subfalcately attenuate; basal leaflets narrowly oblong, often much deflexed; flowering branchlets often numerous, or clustered, thinly spreading-pubescent, unarmed or with a few small prickles, their leaflets oblong to narrowly lanceolate-attenuate, openly dentate with rather coarse acute teeth to appressed-serrate; inflorescence a few-flowered corymbose raceme, either short and terminal or the flowers descending in the axils of the trifoliolate leaves, commonly bracted with one or two oblong or lanceolate unifoliate leaves; pedicels very slender, erectly ascending, mostly 2–6 cm. long, loosely pubescent, unarmed or with a few minute prickles; calyx lobes ovate-oblong, herbaceous-apiculate to short-caudate, often softly appressed-pubescent; flowers medium-sized; petals narrowly oblong to obovate-oblong, 1–2 cm. long; fruit ovoid or subglobose, of medium size, the drupelets sparsely pilose.

Frequent about patches of low thickety growth in dry open places. First flowers June 7, 1908, June 9, 1909; last flowers June 26, 1910.

* RUBUS FLAGELLARIS × PROCUMBENS.

Prostrate and long-trailing; stems branching towards the end and rooting at the tip, rather coarse, soft, greenish and subherbaceous, terete, in great part unarmed but here and there bearing scattered, very short, broad-based and decurved, rather blunt prickles; primary leaves large, trifoliolate, on glabrate or thinly pubescent petioles, which are 5–7 cm. long and armed with scattered decurved prickles; leaflets very broad, becoming 8 cm. wide and 8–10 cm. long, the odd one orbicular or orbicular-obovate, rounded or abruptly narrowed to the base, short-acuminate at the apex, on a petiolule 2–3 cm. long; lateral leaflets mostly cuneate-obovate, often inequilateral and somewhat lobed on the lower margin, subsessile or on short petiolules; leaflets all coarsely and acutely dentate or irregularly cut-dentate, the teeth fewer and passing into appressed serratures towards the entire base; upper surface hispidulous, the lower surface minutely pubescent; flowering branchlets often clustered, 10–20 cm. long, green and herbaceous, striate, glabrate or puberulent, unarmed; inflorescence an irregular long-pediceled, racemose cyme; peduncles often rather stout and clavate above, puberulent, unarmed, the lower axillary from trifoliolate leaves, the upper often subtended by one or more unifoliate bracts; leaflets of the flowering branchlets mostly cuneate-obovate and deeply and irregularly serrate-dentate or laciniate; calyx lobes somewhat villous-pubescent, slender-caudate;

fruit insipid or subacid, large, broader than long, becoming 14 mm. wide; drupelets very large, up to 8 mm. in diameter, bearing scattered pilose hairs.

A single specimen only of this plant was met with, trailing along the border of a low thicket in Millbrook Swamp, August 9, 1906. It has proved to be a particularly perplexing plant. The very large, rounded, and coarsely dentate leaflets of its strictly trifoliolate leaves, coarse subherbaceous and nearly unarmed stem, clustered leafy branchlets, stiff elongated pedicels, and large drupelets give it signal distinction. It can scarcely be doubted that it is a hybrid, and unless it be a compound hybrid, I am at a loss where else to place it than under the parentage here suggested. If a compound hybrid, some involvement with *R. Baileyanus* or *R. Enslenii* might be suspected.

* RUBUS BAILEYANUS × ENSLENII.

R. geophilus Bld., in part.

Ascending, or prostrate and long-trailing, mostly unbranched; stems terete, slender, flexuous, varying from soft and subherbaceous and nearly unarmed to more woody with rather numerous prickles; prickles small, straight and more or less retrorse to rather broad-based and decurved; primary leaves in full development 5-foliolate, on loosely villous-pubescent to glabrate petioles 5–10 cm. long, which are sparsely and weakly or sometimes more strongly armed; leaflets bearing scattered, loosely appressed hairs on the upper surface, thinly short-pubescent beneath, coarsely and acutely doubly dentate or dentate-lobed to somewhat crenately doubly dentate; the odd one ovate-orbicular, with rounded or subcordate base, to rhombic-ovate, acuminate to lanceolate-attenuate, its stalk 1.5–4 cm. long; the lateral leaflets often on short petiolules and, on trifoliolate leaves, usually cleft to form a basal lobe; leaves of the flowering branches on slender petioles mostly 2.5 cm. long, their leaflets ovate to rhombic-oblong, rarely orbicular, variously dentate-lobed; unifoliate leaves coarsely dentate or incised, often 3-lobed, not rarely cordate, sometimes 4–5 cm. broad; inflorescence a short racemose corymb of 3–5 flowers on elongated slender pedicels; often also solitary flowers from the lower axils; pedicels subtended by conspicuous unifoliate or trifoliolate leaves, the two terminal pedicels arising from the axil of a single leaf, all erect, 3–10 cm. long, loosely or thinly villous-pubescent, naked or bearing minute scattered prickles and frequently short gland-tipped hairs, which sometimes extend

into the base of the calyx lobes; calyx lobes rather broad, often with subfoliaceous termination, densely to obscurely subappressed-pubescent; petals oblong to obovate-oblong, mostly 1.5–2 cm. long, young fruit often densely pilose.

Frequent or common on Nantucket in dry or sandy open places or in partial shade. First flowers June 4, 1909, June 7, 1908; still in full flower June 26, 1910.

I have referred here a considerable series of specimens from Nantucket and Long Island, which, although variably intermediate between *R. Baileyanus* and *R. Enslenii* possess in general a certain recognizable individuality. Certain examples, however, appear to be rather arbitrarily separable from *R. Baileyanus*, while others present a similar problem of close relationship to *R. Enslenii*. In general the plant is stouter than *R. Enslenii*, with much broader, more irregularly dentate or lobed leaves and more numerous flowers. As compared with *R. Baileyanus* it is more herbaceous and less prickly, with more coarsely and acutely dentate, often thicker leaves, and weaker pedicels often wholly unarmed.

If, as I have inferred, *R. roribaccus* is a hybrid of *R. Baileyanus* and *R. procumbens*, the plant here considered would seem to answer with the appropriate differences from *R. roribaccus* that might be expected to result if *R. procumbens* were replaced as a parent by *R. Enslenii*.

* RUBUS ENSLENII × FLAGELLARIS.

Low-ascending or prostrate, finally trailing, sparingly branched, sometimes rooting at the tip; stems very slender, subterete, unevenly and often very sparsely armed with short, weak, decurved or retrorse prickles; primary leaves 3-foliolate, on slender, thinly pilose or glabrate petioles, 2–4.5 cm. long; leaflets thin, rather small, 4–6 cm. long, 3–5 cm. wide, mostly obovate, short-acuminate at the apex, more or less cuneate at the base; the lateral pair inequilateral, often rhombic and lobed on the lower margin, subsessile; the odd leaflet on a stalk 0.5–2 cm. long; all thinly pilose-hirsutulous on the upper surface, pubescent to glabrate beneath, on both surfaces bearing minute glands and often subviscid to the touch, irregularly dentate or serrate-dentate with abruptly sharp-acuminate teeth, and often obscurely crenate-lobed; leaflets of the flowering branches sometimes incised; flowering branchlets rather short, 3–12 cm. long, loosely villous-pubescent, unarmed or bearing some minute prickles; inflorescence a 1–7-

flowered, short, slender-pediceled racemose corymb, often naked, but sometimes bracted below with unifoliate leaves; pedicels erect or ascending, very slender, minutely villous-pubescent and usually bearing some minute prickles; calyx pubescent externally, whitened-tomentulose within, the lobes oblong to lanceolate-oblong, apiculate or with a short linear acumination; flowers of medium size or rather small; fruit ovoid-oblong, becoming rather large, 2 cm. long by 1.5 cm. thick, rather large-seeded and subacid, the carpels glabrous or nearly so.

Frequent in dry open ground or in pine groves. First flowers June 7, 1908, June 10, 1909; still some flowers June 22, 1910; ripe fruit August 7, 1906.

A plant not less perplexing than others of its immediate group, in some of its forms approaching very near to *R. Enslenii*, in other forms showing near relationship to *R. flagellaris*. From the former it differs in its larger size and often stronger and more numerous prickles, shorter petioles, broader, more cuneate and more abruptly acuminate leaflets, often subviscid to the touch, and more numerous smaller flowers in subcorymbose racemes. It is a smaller and more pubescent plant than *R. flagellaris*, with weaker prickles, thinner, more coarsely and acutely cut, and more cuneate leaflets, less leafy racemose inflorescence of very slender-pediceled flowers, the carpels glabrous or with an occasional pilose hair.

* RUBUS BAILEYANUS × FLAGELLARIS.

At first ascending, finally long-trailing and rooting at the tip; shoots obscurely angled, becoming subterete, often somewhat branched, armed, often very unevenly so, with rather numerous short, sharp, retrorse or decurved, weak prickles; primary leaves 3-foliolate, or the later ones occasionally 5-foliolate, on thinly pubescent or glabrate petioles 4–6 cm. long, which are armed like the stem; leaflets rather dull green, paler beneath, often strongly purplish tinged, thinly appressed-pubescent on the upper surface, softly short-pubescent to glabrate beneath, acutely and often very irregularly serrate-dentate or cut-dentate and somewhat crenate-lobed; the odd leaflet ovate to obovate-suborbicular, rounded or subcordate to somewhat cuneate at the base, acute or acuminate at the apex, mostly 5–7 cm. long by 4–6 cm. wide, on petiolules 1–2 cm. long; lateral leaflets subsessile to distinctly stalked, mostly rhombic-ovate to ovate-oblong and inequilateral, with a broad basal lobe; flowering branchlets slender, 6–20 cm. long, pubescent or glabrate, unarmed or with some minute scattered

prickles; trifoliolate leaves often subtending long-pediceled axillary flowers and succeeded above by one or more conspicuous unifoliate leaves; leaflets commonly broad and rather coarsely and irregularly dentate or dentate-serrate; inflorescence cymose-racemose; flowers mostly 3–6, on slender erect pedicels 2–8 cm. in length; pedicels loosely pubescent, either unarmed or setulose even on the same plant, often bearing minute scattered, sessile or even stipitate glands; calyx lobes broad, usually merely apiculate, glabrate to tomentulose on the outer surface, cottony-pubescent within; flowers often large, spreading 3–5 cm.; petals mostly broadly oblong; young fruit arachnoid-pubescent.

Frequent in open sandy ground. First flowers June 5, 1910, June 9, 1909, June 11, 1908; mostly out of bloom June 20, 1908.

The plants assembled under this head are a variable series, which agree in showing characters of both the assigned parents. Their actual origin is, of course, exceedingly problematical, especially since certain specimens suggest beside the imputed parents others of the associated and closely related species. It would appear, however, in reviewing the allied crosses, that all other possible hybrids in the group are better accounted for by other plants herein described. The intricacy of the entire problem, which is illustrated no more definitely in this case than in others, well shows the obscurity which must continue to invest it in the absence of that exact knowledge which experimental cross breeding alone can supply.

Upon assimilation of atmospheric nitrogen by fungi

L. H. PENNINGTON

For several years the writer has been interested in the question of assimilation of atmospheric nitrogen by fungi. Experimental work was begun in 1907 upon *Fusarium Zeae*[1] at the suggestion of Professor J. B. Pollock, of the University of Michigan, to whom the writer is indebted for many timely suggestions and criticisms.

The fungus was cultivated in several kinds of organic and synthetic media with dextrose, cane sugar, glycerine, or potassium tartrate as the source of carbon. In all cases the fungus made a good growth when nitrogen was supplied in the form of a nitrate; if very small amounts of nitrogen were supplied, the growth was proportional to the amount of nitrogen; if no nitrogen was supplied there was no growth beyond the mere germination of the spore. In no instance did the most careful chemical analysis of the fungus felt and the medium in which it grew, show any increase in the amount of fixed or combined nitrogen.

These experiments led to similar experimental work with other species of fungi to determine whether any of them have the power to assimilate or fix atmospheric nitrogen, and to ascertain, if possible, why so many contradictory results have been obtained by different investigators. For example, Berthelot,[2] Puriewitsch,[3] Saida,[4] Froehlich,[5] and Latham[6] have reported positive results with *Aspergillus niger*, while Czapek,[7] Koch,[8] and Winogradski[9] give negative results for the same fungus.

Thus far, two species of *Penicillium*, *Aspergillus niger*, an *Alternaria*, and two species of *Fusarium* have been tried by the methods reported by Ternetz[10] and Froelich.[5] After the appearance of Latham's[6] work, in which she reported a very large increase in the amount of combined nitrogen in some cultures of *Aspergillus niger*, which had been supplied with large amounts of ammonium nitrate, a special series of experiments was tried with this fungus in a medium containing a large amount of ammonium nitrate.

In general, the method has been to grow pure cultures of the fungus in 100 c.c. of the solution in one-liter flasks. These flasks were arranged in a series with wash bottles of sulfuric acid and potassium hydroxid and connected by tubes through their rubber stoppers in such a way that air, freed from all combined nitrogen in the form of ammonia and oxids of nitrogen, could be drawn through the flasks by means of a filter pump. Controls were always used, some consisting of 100 c.c. of the medium without the fungus, others of cultures of the fungus in the medium to which enough combined nitrogen had been added to insure a good growth of the fungus. At the conclusion of the growing period chemical analyses were made of the cultures and controls to determine the mount of combined nitrogen in each.

In the chemical analyses different modifications of the Kjeldahl method were used. If it was certain that no nitrate was present, Gunning's modification was found to be the most satisfactory; if nitrates were present, the Gunning-Jodlbauer modification was used. When very small quantities of nitrogen were to be determined, as in the culture media in which no combined nitrogen has been put or in a very small fungus felt, the digestion was carried out in the usual way, made alkaline, then distilled and the distillate caught in a volumetric flask containing a small amount of dilute hydrochloric acid. The amount of ammonia was then determined by the colorometric method in which Nessler's reagent and Nessler's comparison tubes were used. When the amount of nitrogen was about 0.5 milligram or less, this method was found to be more satisfactory than the ordinary method by titration. There is also no danger of error by the carrying over of small amounts of the fixed alkali, during the distillation, for they would make little if any difference in the color.

In all cultures in which dextrose was used there was some growth. In the first series the titration method was used and the total nitrogen content of the several flasks was found to be 0.44–0.62 milligram. A blank with one gram of dextrose gave 0.42 milligram of nitrogen. In the next series, the colorometric method was used and all analyses of blanks and cultures in which cane sugar, glycerine, and potassium tartrate were used gave amounts of nitrogen between 0.30 and 0.37 milligram. At the same time

analyses of blanks and cultures in which dextrose was used gave amounts of nitrogen between 0.44 and 0.47 milligram. From these results it is evident that although the dextrose contained a very small quantity of combined nitrogen to begin with, no nitrogen was assimilated or fixed in any of the cultures.

In the next series of experiments, cultures of two species of *Penicillium*, *Aspergillus niger*, an *Alternaria*, and another species of *Fusarium* were tried with dextrose (a new stock). In all the flasks there was a little growth. The analyses, again by the colorometric method, gave amounts of nitrogen between 0.53 and 0.60 milligram, with but a single exception. One culture of one *Penicillium* gave 0.88 milligram of nitrogen. Since, however, the growth of mycelium was no greater in this culture than in the others it was thought that the excess of nitrogen may have come from something which might have dropped into the flask during the preparation of the cultures or in the analysis.

In the experiments with *Aspergillus* (*Sterigmatocystis*) *niger* in which Latham's method was followed, the following results were obtained: A thick felt of fungus hyphae was formed in each experimental flask during the six-day growing period. Each fungus felt was carefully filtered, dried, weighed, and analyzed for its nitrogen content. The filtrate was also analyzed for its nitrogen. The total nitrogen content for three cultures was 155.8, 154.5, and 153.1 milligrams, respectively (average 154.5 milligrams), and for three control flasks 156.1, 154.4, and 151.3 milligrams, respectively (average 153.6 milligrams). The individual differences were probably due in part to the fact that the culture medium was measured out in an ordinary graduated cylinder. To test the efficiency of the method of analysis, a sample of ammonium nitrate was carefully weighed and analyzed. The computed amount of nitrogen which it should have contained was 177.92 milligrams; the analysis gave 176.9 milligrams. This was considered very close in view of the fact that ammonium nitrate is deliquescent.

Although these results are in harmony with the generally accepted notion that fungi do not have the ability to assimilate atmospheric nitrogen, the persistency with which reports of nitrogen assimilation by fungi appear demands attention and explanation. There are at least two very probable reasons for the positive

results that have been reported by different investigators. The first is the old and often repeated one of experimental error. This reason or objection may properly be given, for it is a well known fact that the determination of nitrogen by the Kjeldahl method presents many difficulties even to those who are more or less expert in making such analyses. This statement will be borne out by an examination of the reviews and reports of controversies among agricultural chemists over nitrogen determinations. One instance may be cited. Barral reports that new block tin condensers were found to absorb considerable ammonia so that accurate results could be obtained only after they had been in use a certain length of time. Such a source of error might cause a whole series of controls to show on analysis a smaller amount of nitrogen than a like series of experimental cultures. When the analyses of six similar cultures in 50 c.c. of culture medium give amounts of nitrogen varying from a loss of 44.9 milligrams in one flask to a gain of 193.6 milligrams in another, it is not safe to assume that free nitrogen has been fixed even although the average for the six cultures may be higher than the average nitrogen content for six controls. The results for the individual cultures should be more nearly uniform or there should be a reasonable explanation for the great differences in the nitrogen content of the different flasks. The objection on the ground of experimental error has added weight when we consider that many of these experiments have been carried out by persons who are amateurs in chemical analysis.

The second reason, which does not seem to have been advanced as yet, is suggested by work such as has been done with *Penicillium* by Thom.[11] It is very possible that there are some strains or varieties of fungi which have the ability to use nitrogen while many other very similar strains do not have that ability. Different species may have been confused and used under the same name by different writers. Undoubtedly several species have been used under the name of *Penicillium glaucum*, and the same may be true with regard to other species of fungi. With the view of obtaining more definite data upon this problem, experiments are now under way in our laboratory to obtain as many as possible distinct strains of fungi by cultural methods and to test them as to their ability to use free nitrogen.

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SYRACUSE UNIVERSITY.

Two new species of Opuntia

Bernard Mackensen

From the writer's studies of Texas cacti, extending over several years, he has been able to ascertain that there are still a number of undescribed species and varieties among the numerous Texas representatives of that interesting family. It may seem strange that a field so often tramped over by botanical collectors should still yield a number of new though comparatively common forms, especially when these belong largely to the conspicuous opuntias. The explanation of this fact is suggested by the writer's own experience in recognizing and differentiating new species and varieties. It was only after keeping the native opuntias, growing all about him, under critical observation for one or more years, and making careful notes, that the writer had revealed to him the presence of undescribed forms. In one case it was not until the maturing of the fruit, which is very characteristic, that the writer was able to make out a clear case of a new species. The transient collector would probably have confounded this with some other species, unless he had perchance visited the locality while the plants were in fruit.

Among the new forms mentioned are two which the writer has characterized as follows:

Opuntia leptocarpa sp. nov.

Plants with somewhat fleshy, terete, or sometimes thick-tuberous, roots: stems mostly ascending, rarely 5 dm. high; joints thin, obovate to oval and elliptic, somewhat glaucous while young, deep green when older, or paler in age, mostly 1 to 2 dm. but sometimes 2.5 dm. long, with subulate leaves 5 to 8 (or sometimes 10) mm. in length: areoles remote, rather small, filled with reddish brown bristles and pale wool when young, the bristles 1 to 7 mm. long and growing dirty brown with age, the lower areoles usually naked, the upper bearing 1 to 4 or sometimes 5 unequal spines, or on some joints mostly spineless; spines whitish, light brown, or mottled, slender, 1 to 3 cm. long or sometimes longer, flattened or nearly terete, twisted, spreading, or sometimes the lowest spine of an areole much reflexed: flowers yellow with a pale reddish

brown (or sometimes darker) center, about 7 cm. broad and 8 to 10 cm. long; petals 4 cm. long, obovate, with a large cusp; stigma white, 6- to 8-lobed, about equaling the stamens: fruit elongated (2.5 to 3.5 cm. thick, 5 to 9 cm. long, or sometimes longer), consisting of an elliptic body, with a narrow (often funnelform) umbilicus and a more or less stipiform base, which is sometimes equal in length to the body but usually shorter, the fruit in ripening becoming purplish throughout and finally crimson externally, the base becoming colored tardily, the taste nauseous: seeds suborbicular, nearly or fully 4 mm. in diameter, when dry gray with a buff margin.

The plant blooms in April and May and produces an abundance of fruit, which ripens in August and September. The fruit is sometimes proliferous.

This species is intermediate between the groups represented by *Opuntia macrorhiza* and *O. Lindheimeri*, respectively. It differs from both in a large proportion of the points covered by the description, so that it is necessary to consider it a distinct species. The slenderness of the fruit is very characteristic, hence the specific name.

The description was drawn from plants growing in their native habitat at San Antonio, Texas, and here, too, the type material was collected in 1910. The type is *no. 618292* in the U. S. National Herbarium.

Opuntia Roseana sp. nov.

Plants with somewhat fleshy terete and thick-tuberous roots: stems commonly several, mostly erect or ascending, sometimes attaining a height of 3 dm., often consisting of an unbranched row of joints; joints mostly relatively thick, obovate to orbicular, 4 to 13 cm. long, often with a shriveled appearance; leaves stout, 2 to 3 mm. broad at base, 4 to 7 mm. long; areoles (often on a decided prominence) filled with pale yellow or whitish bristles 1 to 6 mm. long, only the areoles about the margin of the upper half of the joint armed, or often the entire joint spineless; spines usually white, some joints with a few amber or brownish ones, slender, very short to 2.5 cm. long (or in rare cases 3 to 5 cm. long and very slender), twisted, nearly terete, 1 to 2 or sometimes 3 to an areole, the lower one often reflexed, the others usually erect or spreading: flowers pale yellow with a claret center, about 6 cm. broad and long; stigma white, 5- or 6-lobed, equaling the stamens: fruit obovate-oblong to elliptic-oblong, often narrowly so, 1.5 to 2 cm. wide, 3.5 to 4.5 cm. long, with a crateriform umbilicus, a dull

pink to rose purple outer layer, and a nearly colorless, pleasant-tasted pulp: seeds suborbicular, relatively thick (4 mm. long, 2.5 mm. thick), dirty yellow, with grayish areas on the flat sides, the margin thin and whitish at the raphe.

Flowering in May, the fruit ripening in August and September and not proliferous.

The flowers and fruit of this species show a close relationship to *Opuntia macrorhiza*, but the decided differences in habit, spines, and bristles, and the numerous minor differences, are sufficient justification for regarding it as a distinct species.

The description was drawn from plants growing in their native habitat at Kerrville, Texas, in May, 1910. At the same time a number of plants were transported to San Antonio, Texas, and replanted, and from these the type material was chosen in October of the same year. The type is *no. 618290* in the U. S. National Herbarium.

The species is named in honor of Dr. J. N. Rose of the United States National Museum.

SAN ANTONIO, TEXAS.

Two new species of edible fruits from Mexico

H. H. Rusby

Mayepea macrocarpa sp. nov.

A shrub about a meter high, with elongated, slender branches, which droop or partly recline on adjacent shrubbery. Fruiting branchlets short, stout, brown; petioles 5–10 mm. long, stout; blades 5–10 cm. long, 3–7 cm. broad, oval to obovate, obtuse or subrotund at the base and ending in a very slightly produced, blunt summit, entire, tomentellate underneath, nearly glabrous above, the venation slightly prominent underneath, the principal secondaries about 6 or 8 pairs, with smaller intermediate ones; fruits mostly about 6 to 12, in short, broad, paniculate cymes, at the ends of short stout branchlets borne near the ends of the branches; pedicels very short, mostly broader than long; drupes olivelike, 2–2.5 cm. long and two thirds as broad, ellipsoidal, umbilicate at the base, deep bluish purple, smooth; stone crustaceous, slightly sulcate, occupying about two thirds of the length and diameter of the drupe.

The single specimen seen bore only mature fruit.

Limon Mt., near Balsas, Guerrero, Mexico, at an altitude of about 1400 m., July 2, 1910. Collected by the author.

Morus mollis sp. nov.

A small, spreading, intricately branching tree, resembling *M. alba*, about 4.5 m. high, the trunk nearly 3 dm. in diameter; branches elongated, slender, tough; stipules not seen; twigs and petioles light reddish brown, puberulent when young; petioles 7–15 mm. long, nearly terete, stoutish; blades 3–10 cm. long, 2–6 cm. broad, ovate, equilateral, rounded at the base, abruptly contracted at the summit into an acutely tapering point; margin entire; venation pinnate, prominent on the lower surface, the secondaries about 10–12 on a side, strongly interarching close to the margin and connected by the tertiaries; both surfaces tomentellate, the lower one more so; aments (only pistillate seen) solitary in the axils, the recurved peduncles rather slender and about half as long as the aments. Immature fruits broader than long, when mature rather longer than broad, 1–3 cm. long, pale pinkish-yellow, having the appearance of a raspberry, soft and juicy, of weak flavor and only moderately sweet.

Species much resembling *M. celtidifolia* H.B.K., but the leaves broader and not at all rough.

A single specimen seen, bearing ripe fruit.

Collected in the edge of a gulch near Cuicatlan, Oaxaca, Mexico, July 14, 1910, by the author.

NEW YORK COLLEGE OF PHARMACY.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1907–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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The genera of the fern tribe Vittarieae: their external morphology, venation, and relationships

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(with plates 2–8)

The fern tribe Vittarieae comprises upwards of one hundred species of simple-leaved tropical epiphytic ferns divided among six genera. The tribe is of particular interest because it includes in one of its genera, *Monogramma* Schk., two species which in leaf and stem structure stand at the bottom of the scale of vascular plants. In these species the leaf is a tiny threadlike structure with a single vascular bundle throughout its length. The stem has a central strand of xylem a few cells thick. The sporangia are borne along one margin in a deep groove. It is hardly possible to imagine a simpler type of fern.

The tribe, however, forms a connected series arranged upon the basis of venation pattern, beginning with *Monogramma* and ending, in the most advanced genera, in a well-developed reticulate scheme. The species of the intermediate genera furnish all the intermediate steps between the two extremes. Furthermore, in the ontogeny of the more advanced genera the same series of venation patterns is repeated, affording a double chain of evidence by which the origin of this reticulate type can be traced. The stele varies from a tiny protostele in some of the species of *Monogramma* to an advanced type of siphonostele in *Anetium* et al.

The tribe offers therefore an exceptionally good field for studies in comparative morphology and has also added interest due to

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the fact that the field is almost entirely unworked, except from a purely descriptive standpoint. Luerssen has described the sporangial groove in the genus *Vittaria;* Mettenius has figured a leaf section of a species of the same genus; E. C. Jeffrey, and E. G. Britton and A. Taylor have described and figured the leaf and stem structures of single species, also of *Vittaria.* Goebel has described the gametophytes of species in several of the genera and E. G. Britton and A. Taylor described the same stage in another species. There is, however, no occasion for considering these scattered papers except as of interest in connection with the detailed study.

The present paper deals almost entirely with the comparative external morphology and venation of the genera and the probable relationships indicated by these characters. The data needed in this connection, as well as for the internal morphology on which it is intended to publish later, were obtained in the course of a taxonomic study of the species. The taxonomic problem is in many respects the most difficult of all, as the species are often very similar externally and require microscopic study, as in *Isoetes.* The species groups will be revised from time to time as soon as sufficiently understood. Many of the necessary data for such revisions are now at hand.

The material studied has been almost entirely in the form of dried herbarium specimens. Usually it has been possible to soak these and get fair sections when necessary, although in the case of poorly dried plants soaking does not produce the desired results. The work has been carried on during the last five years at the New York Botanical Garden, and mainly with the material in the Underwood Fern Herbarium at that place. Besides this material I have had also loans from the herbarium of the Botanisk Museum at Copenhagen, the Eaton Herbarium at Yale University, the National Herbarium at Washington, the herbarium of the Bureau of Science at Manila, and from Dr. E. B. Copeland's private herbarium of Philippine ferns. I am grateful to those to whom I owe the privilege of examining the material in these herbaria, to Dr. N. L. Britton of the New York Botanical Garden, to Mr. Carl Christensen of the Botanisk Museum of Copenhagen, to Professor A. W. Evans of Yale University, to Mr. W. R. Maxon of the U.

S. National Museum, to Mr. E. D. Merrill of the Bureau of Science, at Manila, and to Dr. E. B. Copeland of the College of Agriculture of the University of the Philippines. I am also indebted to Dr. H. Christ of Basel for several favors in the way of loans of material, and to Prince Roland Bonaparte of Paris for a specimen and photographs of the type material of *Hecistopteris Werckleana* Christ.

Opportunity has been had to observe living material of several species grown in the conservatory of the New York Botanical Garden. Lastly I have had formalin and alcoholic material of a few species, collected in the field through the kindness of Mr. R. S. Williams of the New York Botanical Garden, and of Mr. E. D. Merrill and Dr. C. B. Robinson of the Bureau of Science at Manila.

Professor Carlton C. Curtis of Columbia University, and Dr. Marshall A. Howe of the New York Botanical Garden have aided me by reading manuscript and my thanks are due them for their help.

In the succeeding pages, the matter is presented under the following headings:

I. Tribal characters.
II. Genera.
III. Ontogenetic stages.
IV. General considerations.
Summary.
Plates.

I. TRIBAL CHARACTERS

(PLATE 2, etc.)

Reference has already been made in a general way to some of the tribal characters of the Vittarieae. These must now be set down in detail before any comparative study of the genera will be profitable. It should be noted that the tribe is to be distinguished from others by no one of the characters alone, the specialized epidermal idioblasts alone perhaps excepted, but depends rather for its separation upon the agreement which the included species show as regards several characters.

Plants comparatively small, essentially epiphytic, i. e., on trees, mossy rocks or logs, rarely on the ground, herbaceous, both as to stems and leaves, never with any sclerenchymatous tissue, the mechanical tissue being in the form of collenchyma.

Stems creeping, covered with clathrate scales.

Leaves simple, entire (*Hecistopteris* excepted), the venation when divided at all, anastomosing (*Hecistopteris* excepted) to form simple areolae without included veinlets.

Sporangia borne in lines of indefinite extent along the backs of some or all of the veinlets (*Anetium* excepted), often forming branching series, sometimes anastomosing, superficial in a few species but usually immersed in the leaf substance in distinct grooves. Epidermis usually provided with specialized cells, the outer walls of which are very greatly thickened.

These characters, with the exceptions noted, hold true for all the species. In habitat the species are all essentially alike, except that one species, *Antrophyum latifolium*, has been recorded by Dr. E. B. Copeland as occurring on the soil. Mr. R. S. Williams, who has collected a considerable number of the species, in the Philippines and in Central and South America, tells me he has often found the plants much wilted in the heat of the day but apparently not injured on this account. Some of them, at least, may often occur in exposed situations, and are probably essentially xerophytic. This may appear in the leaf structure. Thus, in *Vittaria lineata*, the leaf may have the epidermis reinforced by several tiers of thick-walled cells without chlorophyl, presumably to aid in conserving the water supply. This, the commonest American species of the tribe, occurs in exposed situations, epiphytic usually on palms.

The herbaceous character is a uniform feature. In Diel's treatment of the tribe, as presented in Engler and Prantl, Die Natürlichen Pflanzenfamilien, several species of an essentially woody nature are included, and these in the simplest and most tenuous of all the genera, *Monogramma*. These woody plants are mostly American species, which Dr. H. Christ has better separated as a distinct genus, following Presl, i. e., *Pleurogramma* Presl. There is ample evidence to show that they are not only not to be included in *Monogramma*, but that they may not even be retained in the tribe Vittarieae. They are hard, tough little plants with a strong development of sclerenchyma fibers in the

stem and leaves, and as another distinguishing feature, possess a dictyostele, a more advanced type of stele than occurs in the most specialized of the true Vittarieae. As a further proof of their proper differentiation it may be mentioned that they are connected through a series of species with *Polypodium* of the group including *P. serrulatum* and *P. marginellum*, with which they agree in stem, scale, and spore characters, not to mention others.

The clathrate scales are distinctive. (See PLATE 2, FIG. 9–11, 17.) In these only the internal walls are thickened, the result being a latticelike appearance, whence the name "clathrate." The superficial walls remain, but so thin and colorless as often scarcely to be apparent. In the majority of fern scales, the thickening is more even, and the scale usually appears concolorous and more or less opaque.

The outline of the leaves, that is, simple and entire, is to be correlated with the venation, which, except in the three or four smallest species, is always simply reticulate. The reticulation is based in most cases either on the plan of a midvein with uniform lateral areolae (PLATE 2, FIG. 1, 3), or the midvein may be lacking, and then all the veins are uniform (PLATE 2, FIG. 6; PLATE 6, FIG. 2). Consequently there are no predominating vein branches, and therefore no divisions of the leaf. It will be shown later that this areolate type of venation is derived from a free dichotomously divided type. The only exception to the rule of entire leaves, *Hecistopteris*, belongs near the bottom of the scale, and may be considered to have remained stationary in the dichotomously free-veined stage which appears in the ontogeny of several species of which the early stages have been studied. The different venation patterns above *Hecistopteris* depend upon the presence or absence of a midvein and the number of rows of areolae.

The soriation varies with the venation but is essentially of one type for all the species but one, *Anetium citrifolium*, and in this the aberrant type is found to have been derived from the usual plan. This statement may appear at first sight entirely unwarranted, but a survey of the whole tribe will show that the sporangia, with the one exception noted, are borne in lines usually of considerable but indeterminate extent along series of interlocking veinlets. In the simpler, narrowest-leaved genera, the lines

are necessarily unbranched, as in *Monogramma* (PLATE 3, FIG. 3, 8, 11) and *Vittaria* (PLATE 2, FIG. 4, 5), but in the genera with pluriseriate areolation the sporangial lines frequently fork, and in some species anastomose again. *Ananthacorus* is exceptional with its pluriseriate venation and two simple sporangial lines, one along each margin. *Anetium* has appeared even more exceptional as its sporangia have always been described as occurring in round sori and only over the intra-areolar tissue, but, as will be described in connection with the genus, the sporangia are sometimes along the veins even in this genus.

As noted in the tribal description, the sporangia in all but a few species are developed in grooves in the leaf tissue. Sometimes the margins of these grooves are extended to meet and form an indusiumlike protection. This is especially well shown in species of *Monogramma* (PLATE 3, FIG. 2, 7, 9, 15, 16, 17) and *Vittaria* (PLATE 5, FIG. 6, 8, 9). Usually also, there are associated with the sporangia, and of coordinate origin, numerous paraphyses which develop before the sporangia, and probably serve, as Dr. Copeland has suggested, to protect these in their developmental stages. The sporangia are superficial in about ten species, and the paraphyses are wanting in about the same number, but only in part the same species.

The differentiated unequally thickened epidermal cells, the so-called "spicular" cells (PLATE 2, FIG. 7, 8), are said by Goebel to occur only in the Vittarieae. Copeland has recorded their absence in a species of *Antrophyum*. I have not examined the species carefully as to their presence, but have noted them frequently. Goebel, Mettenius, and Luerssen found them present in the several species they studied.

II. GENERA

The species of the Vittarieae seem to fall naturally into seven generic groups. According to the usual taxonomic treatments there are only six, but one of these seems better divided into two. The characters upon which the genera are to be separated are mainly those of venation, but the arrangement of the sporangia is also used in the case of three genera. Of the seven genera here

recognized, three show very simple venation patterns. Thus, *Monogramma* has either a single veinlet in the leaf or at most one, two, or three divisions of the trace forming as many areolae. In *Hecistopteris* the venation consists of a few free veinlets formed by the dichotomy of a single bundle at the base of the leaf. In *Vittaria* the venation consists of a midvein with a single row of simple areolae along each side. The number of the areolae in each row may be as few as one, or there may be very many, but the pattern is always simple.

In the other four genera, *Anetium*, *Ananthacorus*, *Antrophyum*, and *Polytaenium*, as here described, there are always more than two rows of areolae across the leaf, so that the name "pluriseriate" may be applied to this type of venation. For want of a better term the three genera named in the preceding paragraph may be designated the "simpler genera."

The generic characters may be briefly contrasted as in the following taxonomic key:

Veins free-forking. 2. *Hecistopteris*.
Veins, if more than one, anastomosing to form simple areolae.
  Sporangia in a single marginal or dorsal line. 1. *Monogramma*.
  Sporangia in two or more lines or in small groups.
    Venation consisting of a midvein with a row of areolae along each side. 3. *Vittaria*.
    Venation of more than two rows of areolae across the leaf.
      A percurrent midvein present, the lateral veins smaller and secondary.
        Sporangia in two submarginal rows along the outermost veinlets. 5. *Ananthacorus*.
        Sporangia usually in more than two lines, but never only on the outermost veinlets. 4. *Polytaenium*.
        Sporangia usually in small groups or patches on the intra-areolar spaces. 6. *Anetium*.
      No percurrent primary midvein. 7. *Antrophyum*.

A. SIMPLER GENERA

1. MONOGRAMMA Schkuhr, Crypt. Gewächse **1**: 82. *pl. 87*. 1809

Type species, *Pteris graminea* Poir. Type specimen from the Bourbon Islands, *Roemer*.

The genus *Monogramma*, properly delimited, that is, with the polypodioid American species excluded, includes five species, all

native in the Old World tropics. Among these five species are two that show the simplest leaf structure known among vascular plants. In these the leaf has only a single simple vein (PLATE 3, FIG. 1, 20) and in one of these two species the whole leaf is only 2–2.5 cm. long, and scarcely 1 mm. wide. In the other three species, the leaf trace may divide once or twice to form one or two areolae, but even in these species, the leaves are very tenuous (PLATE 3, FIG. 6, 10, 12, 13).

In characters other than those of venation, the species all agree with the tribal description given. The scales are clathrate; spicular cells have been recorded, although not all the species have been examined as to this character; and the sporangia are in indeterminate lines along the vein or veins and are protected by being depressed in the leaf tissue. Mixed with the sporangia are paraphyses of the type common for the tribe. As it happens, these take two forms in *Monogramma*. In three of the species, viz., in *M. paradoxa*, *M. subfalcata*, and *M. trichoidea*, occurs what is probably the simplest type of paraphysis in the tribe. The end cell, which in other species is usually capitate and strongly colored, or otherwise differentiated, is in these three species merely rounded off, and hyaline like its stalk cells. The whole structure is often hard to distinguish from the pedicels of the sporangia (PLATE 3, FIG. 16, 18).

In the other two species, *M. graminea* and *M. dareicarpa*, the paraphyses have strongly colored and capitate end cells, which collapse in a characteristic way when dried, the end becoming depressed so that the end cell then appears like a small bell (PLATE 3, FIG. 4, 5). Paraphyses of this type are also found in *Hecistopteris* and in one group of *Vittaria*.

The spores were seen for all the species but *Monogramma subfalcata*, and are of the triplanate type, and like those of this type in the other genera of the tribe.

Because of the interest which may attach to these simplest of all ferns, and the need of exact determinations, a brief descriptive key is offered. All the species have been adequately differentiated by figure and description but only in separate places. There are good figures of the gross leaf anatomy of four of the five species, but for comparison with each other and with the

species of the other genera of the tribe, all five are here shown together in one plate (PLATE 3). The species may be compared as follows:

Leaf trace undivided throughout, paraphyses distinctly capitate.
  Leaves 5–10 cm. long (Mauritius). *M. graminea.*
  Leaves not more than 3 cm. long (Borneo, Philippine Is.). *M. dareicarpa.*
Leaf trace with 1–2 or rarely 3 divisions, paraphyses not capitate.
  Leaves hairlike; twisted, with sporangia in 1–3 separated grooves in a line along the leaf (Philippine Is.). *M. trichoidea.*
  Leaves flat, more or less falcate, the sporangia in a single or in two parallel grooves.
    Leaves about 2.5 cm. long, with only one areola and soral line (New Hebrides). *M. subfalcata.*
    Leaves much longer, up to 25 cm. long, often with two areolae and soral grooves (Oceanica and Malaysia). *M. paradoxa.*

The structure of the leaves and their venation is sufficiently well shown so that little description is needed. In *M. paradoxa* the majority of the leaves show only a single areola and sporangial line, but the type with two, as figured, is not unusual. In *M. trichoidea* the section shows that the leaf trace may divide, at least along some of the soral grooves, but the material does not soak up well and it was not determined whether this is true in all cases. The shape of the sporangial groove appears from the gross study of a number of leaves to vary somewhat, being often more nearly equal-lipped. *M. graminea* and *M. dareicarpa* are alike in the type of soral groove. There is possibly a slight difference in the shape of the paraphyses. This, together with the difference in size and the wide separation in range, makes adequate specific separation. *M. subfalcata* is similarly related to *M. paradoxa*, and is not so well separated in distribution, but from the material studied, and this included a considerable series of *M. paradoxa*, their separation appears justified.

From the standpoint of species differentiation, *Monogramma* is interesting as showing the possibilities of variation in the very simple structure involved. The genus stands at the bottom of the scale in comparison with other vascular plants, the mature leaf being simpler in structure than the stage which appears in the first leaf in other ferns. The differentiation is, as noted, usually coupled with differences in the distribution, but at least three of the species may occur in the same general region.

The generic separation of *Monogramma*, as compared with the simpler species of *Vittaria*, depends on the simplicity of the venation and the simple sporangial line. In *M. graminea*, *M. trichoidea*, and *M. dareicarpa*, the line is lateral, as shown in the plate. In the other two species it is dorsal, but even in the two-areolate leaves of *M. paradoxa*, the two grooves open together along the midvein and at maturity form but a single line of sporangia. But between this type and the type characteristic of *Vittaria* there is really no very wide "generic" distinction.

2. HECISTOPTERIS J. Smith, London Jour. Bot. 1: 193. 1842

Type species, *Grammitis pumila* A. Spreng. Syst. Suppl. 31. 1828. (Type locality, "Ad corticem arborum, in Surinam. —Weigelt.")

Hecistopteris is commonly recognized as including a single epiphytic species, *H. pumila* (A. Spreng.) J. Sm., native in northern South America. Excluding the simple-veined species of *Monogramma*, *Hecistopteris pumila* is the only free-veined species in the whole tribe of the Vittarieae. It is, like *Monogramma*, of particular morphological interest because of the very primitive character of its venation, both as compared with the more highly developed genera of the Vittarieae and as regards ferns in general. Probably all ferns in whatsoever family, *Monogramma* alone excepted, exhibit in their very early ontogeny a stage of development in which their venation corresponds to the type characteristic of mature *Hecistopteris*.

As noted above, only one species is commonly recognized. Dr. Christ has given subspecific names to three variant forms but without urging their recognition as species. The original figure shows plants similar to that illustrated in FIG. 12–16 of PLATE 4. FIG. 1–8 and 19–22 of the same plate are taken from plants of two Bolivian collections and appear to represent a rather distinctive development, approaching in some respects to the outline and venation of the larger species of *Monogramma*. Such a form is perhaps worthy of further study with a view to determine whether the form differences are not correlated with distinctive distribution.

The stem is very slender and dorsiventral in structure. Only herbarium material has been obtainable for study and it has not been possible to obtain any of this which would soak up well enough to allow a good section to be made. The thickness of the stems, not greater than that of the simpler species of *Monogramma*, would indicate that the internal structure must be very simple and deserving of thorough morphological investigation.

The leaves as figured (PLATE 4) are sufficiently described as to venation, this being merely free and dichotomous. As to soriation, apparently any of the ultimate and next larger veins may bear sporangia. These are borne quite superficially, an unusual feature in this tribe. The only protection to the sporangia is afforded by the paraphyses, assuming that these develop earlier than the sporangia, as is true in all the species of the tribe in which their development has been noted. In this way the young sporangia would be partially protected during the earlier part of their development.

The paraphyses are of the type already described for *Monogramma graminea* and *M. dareicarpa*, and further, they are practically identical with those characteristic of *Vittaria* of the group of *V. remota* Fée. The spores are diplanate, another point of similarity with the *V. remota* group. The scales are of the usual clathrate type.

Goebel, by his study of the gametophyte of *Hecistopteris*, first succeeded in convincing botanists that this genus is properly to be associated with *Monogramma* and *Vittaria* rather than included as a species of the "catch-all" genus *Gymnogramma* as interpreted by earlier writers. John Smith, however, had already pointed out clearly, in connection with his original description of the genus, that it is "only distinguished from that genus [*Monogramma*] by the cuneiform, usually laciniate character of its fronds, and consequent forked venation." His statement would have been more accurate if he had partly reversed the order of the words and made the outline of the "fronds" the consequence of the forked venation.

The taxonomic separation of *Hecistopteris* is simple by reason of its free-forking venation. As a matter of fact, however, its actual phylogenetic separation from the simpler species of *Vittaria*, especially of the *V. remota* group, is probably not very great.

Notice should be taken here of two other names recently proposed in *Hecistopteris*, viz., *Hecistopteris Werckleana* Christ (Bull. Herb. Boiss. II. 7: 265. 1907), and *H. minima* (Baker) Benedict (Bull. Torrey Club 34: 457. 19 O 1907). The latter is the earlier species and was originally described by Baker as *Antrophyum minimum* and so appears in Christensen's Index Filicum. Dr. Christ's species *Werckleana* was also originally described as an *Antrophyum*, but was soon after shifted by him into *Hecistopteris* on account of the occasional forking of the tips of the leaves. This, however, is merely the abnormal forking frequent in all species of ferns. As it turns out, *Antrophyum Werckleanum* is identical with *A. minimum* Baker. This I have been able to determine through the kindness of Prince Roland Bonaparte, from whose herbarium a plant of the original collection of *Werckleana* has been obtained (PLATE 2, FIG. 4. Compare with FIG. 5 of the same plate, drawn from type material of *H. minima*). Both have the venation of *Vittaria*, and the species, which will need to be known under Baker's name, should henceforth be called **Vittaria minima** (Baker) Benedict comb. nov. (PLATE 2, FIG. 4, 5). *Antrophyum minimum* Baker, Ann. Bot. 5: 448. 1891.

Hecistopteris minima Benedict, Bull. Torrey Club 34: 457. 19 O 1907.

Antrophyum Werckleanum Christ, Bull. Herb. Boiss. II. 5: 11. 1905.

Hecistopteris Werckleana Christ, Bull. Herb. Boiss. II. 7: 265. 1907.

3. VITTARIA J. E. Smith, Mem. Acad. Turin. 5: 413. *pl. 9.* 1793

Type species, *Pteris lineata* L. (Type specimen from Santo Domingo.)

The genus *Vittaria* shows in its simplest species, *V. sikkimensis* Kuhn, a venation similar to that of *Monogramma paradoxa*. (Compare PLATE 3, FIG. 13, and PLATE 5, FIG. 18, 20, respectively.) It differs even in this species in having two separate sporangial grooves, and this character furnishes the most obvious generic mark. The venation consists always of a median vein with a row of areolae (1–many) along each side. This venation may be characterized as biseriate.

Vittaria includes probably at least forty species and is the largest genus of the tribe. More than half of these are native in the Old World tropics, and of these I am unable to give the exact number, owing to insufficient material of all except the Philippine species. Christensen in his Index recognizes forty-six species, of which fifteen are American. Several of these may be reduced to synonymy or referred to other genera, but there appear to be several undescribed and some others listed as synonyms which should be recognized, so that the number of species to be recognized will remain about the same.

According to the tribal description, species of a woody texture, with sclerenchymatous tissue, and with dictyostelic vascular systems, must be excluded from *Vittaria*. This will reduce Christensen's list of Old World species by two or three names, such as *V. minor* and *V. pusilla*. Dr. Christ puts these species in *Pleurogramma*, and there appears to be a close relation to this group, but the venation is somewhat different from that in the American species, in which it consists of a midvein with free pinnate veinlets. In the so-called Old World Pleurogrammas, the lateral veinlets form two rows of areolae, which, however, have free outer veinlets. Like all other groups of the tribe Polypodieae, these two stand much in need of a realignment.

The characteristic venation of *Vittaria* is well shown in the figures of *V. minima* in PLATE 2, FIG. 4 and 5. All the various modifications shown in PLATE 5 are easily reducible to this simple pattern. The greatest differentiation that takes place has to do with the direction in which the areolae are elongated; if in a line parallel to the midvein, the type shown in PLATE 5, FIG. 1, results. This is characteristic of all the very narrow species like *V. lineata* and others, including a majority of the species in the genus. The species of this type figured, *V. intramarginalis*, does not begin to show the extent to which this leaf elongation may be carried. Leaves of *V. lineata*, not more than three or four millimeters in breadth, reach a length of one thousand millimeters. The veinlets in such cases are much farther apart than indicated in the figure of *V. intramarginalis*. In the other type, the areolae are elongated in lines parallel to the first direction of the veinlets, that is oblique to the midvein. This results in much broader leaves, as shown in FIG. 7, 10, and 11 of PLATE 5.

These variations in venation are not accompanied by any features which would indicate that there is any tendency to subgeneric grouping on this basis. In fact there are all intergradations between the extremes of both types; the two forms occur in both the eastern and western hemispheres, and, moreover, in both the natural subgenera into which *Vittaria* may be divided.

These may be differentiated as follows:

EUVITTARIA. [Type species, *V. lineata* (L.) J. E. Smith.]

Stem dorsiventral, phyllotaxy distichous, leaf trace double in all but a few simple species, stem and petioles pale. Spores diplanate or triplanate, paraphyses variable.

Includes most of the species, all the Old World species, and more than half those native in America.

Radiovittaria subgen. nov. (Type species, *V. remota* Fée.)

Stem radial, phyllotaxy polystichous, leaf trace always single, stem and petioles brown, owing to the highly developed collenchymatous strengthening tissue. Spores diplanate, paraphyses always of the *Monogramma graminea* type (PLATE 2, FIG. 18–20).

Includes *V. remota* Fée, *V. Gardneriana* Fée, *V. minima* (Baker) Benedict, *V. stipitata* Kunze, and *V. Orbignyana* Fée; also two Bolivian species not yet described.

These two subgenera show points of difference often considered as of generic value but the venation and soriation are alike in both, and the needs of descriptive taxonomy are probably better served by retaining both groups under the one generic name *Vittaria*.

The stem externally appears about the same in all species of *Vittaria*. In some of the Old World species the internodes are of considerable length, but in most of the species the leaves are close together. The difference noted as to the color of the *Radiovittaria* stem is not apparent until the scales are removed. The scales are essentially the same in all the species, the only variation being in size and amount of thickening in the internal walls. (See PLATE 2, FIG. 9–11, 17.) Also in some species these walls may show granular or papillose markings. The spores, as already noted, are either diplanate or triplanate. The paraphyses show a number of different forms, which are of considerable value in grouping the

species for identification but which need not be described here. They consist, as noted in the tribal descriptions, of enlarged, usually brown or yellow end cells, borne on single or branching multicellular pedicels and associated with the sporangia.

The sporangia are always borne along the outer interlocking portions of the veinlets as continuous lines along the greater part of the lamina (PLATE 2, FIG. 4, 5). With perhaps not more than two exceptions, the sporangial line is always in a groove or depression of greater or less extent. FIGURE 12 of PLATE 5 shows a very slightly depressed groove. FIGURES 6, 8, 9, and 21 of the same plate show some of the deeply grooved species and the variety of ways in which the groove may be disposed. According to the development of the grooves, the species have sometimes been described as possessing indusia or otherwise. FIGURES 6 and 12, respectively, illustrate these two types. The use of this term is hardly advisable as there is no real differentiation of one lip as a distinct indusium. This is equally true of *Monogramma* (PLATE 3, FIG. 2, 7, 9, 14, 15, 19), as also of all the species in which the receptacle is sunk in a groove.

The various types of sporangial groove have been thoroughly studied and figured by Luerssen. (Filices Graeffeanae, in Schenk and Luerssen, Mitt. Gesammt. Bot. 1: 57. *pl. 11, 12.* 1871.) This, by the way, is the only feature of the Vittarieae that has been adequately studied through any considerable number of species.

It has already been noted that the venation of the simplest species of *Vittaria* is essentially the same as that of *Monogramma paradoxa*, and that the separation in this direction must depend on the separate sporangial lines. With respect to the more advanced genera, the characters of the venation furnish the best distinction. As regards the soriation, certain species of the more advanced genera appear sometimes like *Vittaria*.

B. PLURISERIATE GENERA

The remaining genera of the tribe all show a more advanced type of venation than that of *Vittaria*. If the latter with its two separate rows of areolae may be called "biseriate," the more complex type may well be named "pluriseriate," since there are

always more than two rows of areolae. Of this pluriseriate type two distinct patterns occur in the tribe, the distinction depending upon the presence or absence of a midrib (PLATE 6, FIG. 1 and 2).

That this distinction is important is evidenced by the distribution of the species. All the American species possess a distinct primary vascular strand, a complete midrib, in relation to which the areolation is secondary and derivative. In the Old World species, on the contrary, there is no complete primary axial vein. There occurs in some few species of this region an incomplete midrib, but in none of these species is this midrib ever maintained as predominant throughout the leaf, and in all the Old World species the areolation is in part or entirely derived by the dichotomy of the several veins present at the lower part of the blade.

As further evidence of the fundamental character of this distinction in venation, shown in the mature sporophytes, the fact should be noted that among the American pluriseriate species three distinct genera, based on sporangial arrangement, are recognized; that is to say, subsequent to the separation of the continental groups on the basis of venation, one of these groups has been further differentiated into three well-marked genera. Surely continental venation differences in this case deserve precedence over intracontinental soral variations. Additional evidence is offered farther along in connection with the description of the ontogenetic stages.

Notwithstanding, however, this accepted generic separation within one venation group, the larger number of American pluriseriate species have been retained under the same generic name as the Old World species, viz., *Antrophyum* Kaulf. The principal reason for such retention under one name has been the fact that the soriation is somewhat similarly indefinite in both groups. But it should be apparent, I think, as expressed above, that as a generic character the venation pattern must take precedence over the sporangial arrangement, and that *Antrophyum* as at present delimited, includes two generic groups more distinct from each other than are the three pluriseriate groups which are now kept apart because of different sporangial arrangement.

For this reason the American species formerly classified under the name *Antrophyum* are here included under a different name,

Polytaenium Desv., and a revised description is given with *P. lineatum* (Sw.) Kaulf. as the type species. *Antrophyum* proper is typified by an Old World species, *A. reticulatum* (Forst.) Kaulf. The distinguishing feature of *Polytaenium*, the double or "twin-net" type of venation as compared with the single net type of *Antrophyum* is shown typically in PLATE 6, FIG. 1.

4. POLYTAENIUM Desvaux*

Type species, *Hemionitis lineata* Sw. (Type specimen from Jamaica.)

Herbaceous epiphytic ferns with creeping dorsiventral rootstocks and fasciculate, simple, entire leaves, the phyllotaxy distichous; scales of the rootstock and leaf bases clathrate.

Leaves glabrous except for a few scales at the base, linear to broadly oblanceolate, long-decurrent below; leaf trace double, the bundles uniting in the leaf base to form the primary midvein, from which branch secondary veinlets to form two or more rows of simple areolae along each side.

Sporangia along the veinlets and sometimes along the midvein in lines of indefinite extent, often branching, sometimes reticulate, usually immersed in slight grooves; paraphyses absent; spores triplanate (except in one species).

During the nearly four years since my first paper dealing with the species of *Polytaenium* was published, I have had occasion to examine from time to time newly collected herbarium material. More recently I have been studying the internal stem characters and have made sections of the leaves in order to gain a better understanding of their characters. This study has in general

*Under the title The Genus *Antrophyum*—I. Synopsis of the subgenera and the American species (Bull. Torrey Club 34: 445–458. 19 O 1907), I have already given a taxonomic treatment of the species to be included in *Polytaenium*. At that time, basing my descriptions on a careful external study of the plants, I recognized nine species. Eight of these should now be named anew as follows: (combinationes novae) **Polytaenium cayennense** (Desv.), *Hemionitis cayennensis* Desv. Berl. Mag. 5: 311. 1811; **Polytaenium lanceolatum** (L.), *Hemionitis lanceolata* L. Sp. Pl. 1077. 1753; **Polytaenium brasilianum** (Desv.), *Hemionitis brasiliana* Desv. Prod. 216. 1827; **Polytaenium discoideum** (Kunze), *Antrophyum discoideum* Kunze, Bot. Zeit. 6: 702. 1848; **Polytaenium anetioides** (Christ), *Antrophyum anetioides* Christ, Bull. Herb. Boiss. II. 5: 12. 1905; **Polytaenium Dussianum** (Benedict), *Antrophyum Dussianum* Benedict, Bull. Torrey Club 34: 453. 19 O 1907; **Polytaenium Jenmani** (Benedict), *Antrophyum Jenmani* Benedict, Bull. Torrey Club 34: 454. 19 O 1907; **Polytaenium ensiforme** (Hook.), *Antrophyum ensiforme* Hook. in Benth. Pl. Hartweg 73. 1841.

confirmed the results of the early external study and has also added some valuable facts to aid in species differentiation.

One result of this further study has been the discovery of an undescribed species, which by reason of its venation and sporangial arrangement, serves as a connecting link with *Vittaria* and therefore deserves a name and description in this place.

Polytaenium quadriseriatum sp. nov.

Rootstock creeping, dorsiventral, the scales clathrate; leaves fasciculate, in two rows, firmly herbaceous, the petiole 3-angled, the blade linear, 12–20 cm. long, 3–5 mm. broad, narrowed very gradually and equally both ways, the apex acute; venation consisting of a midvein with two rows of areolae along each side; sporangia in two long continuous deep grooves along the outer margins of the costal areolae, with sometimes additional short grooves along the outer areolae, the margins of the grooves produced so as to meet, covering the sporangia when young; spores triplanate, no paraphyses. (PLATE 7, FIG. 8–10.)

Type from Hayti, *Nash & Taylor 1360*, in Underwood Fern Herbarium, N. Y. Botanical Garden.

The material on which this species is based was originally identified as *Vittaria intramarginalis* and was discovered during a study of that species. At first this identification was maintained and the specimen was looked upon as an aberrant *Vittaria*, but further study has made it evident that it should not be retained in that genus and species, but is rather more nearly related to *Polytaenium lineatum*. It differs from the *Vittaria* in the 3-angled stipe, and in color, texture, venation, and soriation. It resembles *P. lineatum* in these respects, but differs from this species markedly in size and general appearance. If comparison is made between FIGURES 3 and 8 of PLATE 7, *P. quadriseriatum* will appear like *P. lanceolatum* in venation, but the soriation as figured for the latter species (FIG. 4) is entirely distinctive. *P. quadriseriatum* is particularly interesting, however, because of its position intermediate between the several species and two genera.

Question may be raised as to the necessity of two genera since there are connecting species. This does not seem an adequate objection, in view of the wide difference between the two types, as shown in most species, and since *Vittaria* in its special line of

development, generally shows as wide a divergence from the simple type as do the species of *Polytaenium*. Whatever its proper rank or name, the significance of *P. quadriseriatum* is the same, and it serves to connect the pluriseriate venation pattern of *Polytaenium*, *Ananthacorus*, and *Anetium* with that of *Vittaria*.

The venation of *Polytaenium* is illustrated by figures of several species (PLATE 6, FIG. 1; PLATE 7, FIG. 3–6, 8). By reference to these figures, it may be noted that the areolae decrease in size from the midvein toward the margin. In the narrow-leaved species, which have all the areolae parallel to the midvein, this decrease takes approximately the ratio of 1 : ½ : ¼, the length of a costal areola being taken as the unit. In the broader-leaved species, only the costal areolae are parallel to the midvein, and the divergence of the others increases their proportionate length, although a steady decrease in size toward the margin is still the rule. In the broadest species, *P. Jenmani*, as also in *Anetium*, the divergence in the outermost areolae approaches an angle of 90°. The other species furnish all gradations between this broadest type and that of the narrowest species, *P. quadriseriatum*.

The external stem characters are practically alike for all the genera, the only difference being in the size. The scales are of the general clathrate type and are alike except for some slight variations in size, shape, and margin. The spores are triplanate in nine out of the ten species here recognized, and these same nine species lack paraphyses.

One species, *Polytaenium ensiforme*, has both diplanate spores and capitate pyriform paraphyses. It was recognized in my earlier paper as a distinct subgenus, *Scoliosorus* Moore, but perhaps this distinction is unwarranted.

Another subgenus based on a soral difference, namely, *Polytaenium* Desv., was also recognized at that time, including a single species, "*Antrophyum*" *lineatum*. If this were worth maintaining, *Polytaenium quadriseriatum* would now have to be included, the two species together to constitute the subgenus *Eupolytaenium*, but there does not appear to be any necessity for such separation.

The sporangia are borne in lines of greater or less extent, in some species always simple, in others branching and, in still others incompletely anastomosing. In most of the species of *Polytaenium*

the lines are in slight grooves or even superficial. In the *P. lineatum* type the lines are much elongated, and, with rare exceptions, unconnected (PLATE 7, FIG. 8). In the pair of species which show this type, the sporangia are also developed in deep, partly covered grooves. In *P. lanceolatum*, a species which belongs next to *P. lineatum*, the sporangia are nearly superficial and in short, often more or less branching lines along the longitudinal veinlets (PLATE 7, FIG. 4). The specimens of *P. lanceolatum* figured are of the variety *Feei*. Typical *P. lanceolatum* is much longer and narrower in proportion, and shows soriation not so unlike *P. lineatum*, but as *P. quadriseriatum* and *P. lineatum* are situated near the border line between *Vittaria* and *Polytaenium*, it is not surprising that they should show a connecting type of soriation. In true Old World *Antrophyum*, all grades of soriation between a vittarioid type and the dichotomous type of *A. reticulatum* and *A. plantagineum* (PLATE 7, FIG. 11), and further a practically complete reticulation, as in *A. Boryanum*, may be found.

Polytaenium may be considered as a well-marked genus, notwithstanding its obvious origin from a form like *Vittaria*. The whole tribe shows evidence of being of recent origin, and if so, it is not strange that the connecting links between the genera have been maintained.

5. ANANTHACORUS Underwood & Maxon, Contr. U. S. Nat. Herb. 10: 487. 1908. (PLATE 2, FIG. 2 and 3)

Type species, *Pteris angustifolia* L. (Type specimen from the West Indies.)

Ananthacorus includes a single species, *A. angustifolius*, which has been included during its existence in a large number of genera of varying affinities. Goebel pointed out its relationship to the Vittarieae on the basis of its spicular cells but did not give it a generic name. Several attempts have been made so to signalize it but they have failed by reason of nomenclatorial difficulties until the action was taken which gave it its present name. Christensen, following Diels, included it with *Vittaria* because of its two sporangial lines (PLATE 2, FIG. 3), but that location can scarcely be maintained. These two lines are not homologous with those of *Vittaria*. If they were, they would be located along the costal

areolae, for in the pluriseriate type of venation these are true homologues of the costal and only areolae in *Vittaria*. *Ananthacorus* might better be considered as included in *Polytaenium* rather than in *Vittaria*, but the definitely localized fruiting lines, which are never so definitely localized in *Polytaenium*, furnish adequate ground for generic separation.

The venation as figured (PLATE 2, FIG. 3) is of the ordinary pluriseriate type described for *Polytaenium*. The scales are clathrate. The sporangia are in shallow grooves (PLATE 2, FIG. 2). The spores are diplanate. Pyriform capitate paraphyses of an ordinary sort are present.

6. ANETIUM Splitgerber, Tijdschr. Nat. Gesch. 7: 395. 1840.
(PLATE 2, FIG. 1)

Type species, *Acrostichum citrifolium* L. (Type specimen from Martinique.)

Anetium, with a single species, *A. citrifolium*, has long appeared an anomalous genus and its proper position as regards other ferns has been in question, but I think I have here sufficient evidence to locate it properly.

Its venation is of the *Polytaenium* type in its highest development and does not need further discussion, neither do its other characters of vestiture, spores, or epidermal cells, all of which agree with the general types characteristic of the tribe.

Only the arrangement of the sporangia has caused uncertainty as to its systematic position. The sporangia have always been described as occurring only over the parenchyma within the areolae, and this is certainly the ordinary position. This has naturally resulted in placing the genus with the Acrosticheae, in which such sporangial position is the rule. In the Underwood Fern Herbarium, however, is a specimen which shows the variation in soral position indicated in the figure (PLATE 2, FIG. 1). In the lower part of the leaf the sporangia are along the veinlets in rather complete reticulation. Farther up this passes over into the usual *Anetium* type, but this single specimen is enough to show that the *Anetium* type has probably been derived from the *Polytaenium* type and that *Anetium* may be definitely and properly located in the Vittarieae.

The stem is much more elongated than in any other member of the tribe, the leaves being far apart. Judging from the peculiar stele, *Anetium* represents the greatest degree of modification in the whole tribe.

7. ANTROPHYUM Kaulfuss, Enum. Fil. 197. 1824

Type species, *Hemionitis reticulata* Forst. (Type from Upolu.)

The genus *Antrophyum*, as properly limited to the Old World plants having pluriseriate venation, includes approximately twenty-five species. This number is in excess of that given by Christensen, but it was determined after a careful study of material which contained nearly all the species described, and the estimate is conservative rather than excessive. The genus includes all the Old World species of Vittarieae having more than two rows of areolae through the leaf.

The origin and arrangement of the areolae is, as noted under *Polytaenium*, quite different from the type characteristic of that genus. Instead of proceeding from the midvein at regular intervals, as in *Polytaenium*, they are all directed toward the base and arise by the dichotomy of basal veins. Moreover, even when compared with the narrow types of *Polytaenium*, there is a considerable difference shown. In *Antrophyum*, areolae laterally adjacent to each other usually are practically equal in origin and length. In *Polytaenium*, on the contrary, especially in the narrow species, the areolae of the second row are always much shorter than those of the first, and are plainly secondary and derivative when compared with the first (PLATE 7, FIG. 2).

This difference between *Antrophyum* and *Polytaenium* is well illustrated in PLATE 6, FIG. 1 and 2. In *Antrophyum plantagineum*, the areolae decrease in size from the base toward the apex; in *Polytaenium cayennense*, the decrease takes place from the midvein outward.

It has already been noted that some species of *Antrophyum* possess an incomplete axial vein. This is especially evident in *A. semicostatum*, in which the midvein or "costa" may extend upward through half or even somewhat more of the lamina, but this species does not, on this account, serve to connect the *Antrophyum* venation pattern with that of *Polytaenium*. The midvein

in *A. semicostatum* is rather a parallel development than an indication of direct relationship with *Polytaenium*. *A. semicostatum* is very clearly related to the other Antrophyums.

As far as the characters of the mature sporophyte are concerned, *Antrophyum* seems to resemble most certain of the more divided forms of *Hecistopteris*. (Compare PLATE 4, FIG. 4, 5, etc., with PLATE 2, FIG. 6.) The leaves of *Hecistopteris* here referred to, possess a type of venation which is easily comparable with that of *Antrophyum nanum* Fée, shown in the last figure.

It is this type of venation, i. e., that of *A. nanum*, which is found in more or less modified form in all the larger species of *Antrophyum*. It is a type that seems to be better adapted than the *Polytaenium* type to the development of broad-leaved species, as *Antrophyum* includes at least two forms with orbicular blades and several others approaching this shape. One other interesting consequence of this dichotomous venation is to be noted, i. e., the leaf blade in all but a few species is broadest above the middle. In *Polytaenium* the blades are usually parallel-sided or elliptic.

In the characters other than those of venation there is considerable variation in *Antrophyum*, and because of a conjunction of several of these variations in connection with geographic isolation, I have separated a group of three or four species as a distinct subgenus, *Antrophyopsis*, native in southern Africa and adjacent islands. The differences are stated below in connection with each character.

The soriation in *Antrophyum* proper is variable between the limits shown in FIG. 1 of PLATE 7, and FIG. 2 of PLATE 6, respectively; that is, the sporangia may be borne either in single lines of greater or less extent (PLATE 7, FIG. 1 and 7), or they may be in lines that branch considerably (PLATE 7, FIG. 11). Always in *Euantrophyum* they are sunk in grooves. In *Antrophyopsis*, on the contrary, the soral lines are practically completely reticulated, and are entirely superficial. The spores in *Euantrophyum* are triplanate. The spores in *Antrophyopsis* are diplanate. The paraphyses are clavate in *Antrophyopsis*. In *Euantrophyum* the paraphyses may be either clavate or filiform. The stipe scales are of course clathrate in both, but the scale ribs in *Euantrophyum* are smooth; in *Antrophyopsis* they are verrucose.

A small but marked difference in the venation emphasizes further the distinction between the two groups. In *Euantrophyum* the marginal veinlets are rarely if ever free, but rather as indicated in FIG. 2, PLATE 6. In *Antrophyopsis* the outermost veinlets are free quite to the margin, and the latter is always more or less thickened. It should be stated, however, that although *Antrophyopsis* is confined to African regions, *Euantrophyum* is also represented there by one species, *A. immersum* Hook., outside of the usual subgeneric range in Oceanica and Malaysia.

Further reference will be made to *Antrophyum* in connection with the ontogenetic studies.

III. ONTOGENETIC STAGES OF VITTARIEAE

I have endeavored to show in connection with a study of the mature sporophytes of the various vittarioid genera that these form together a complete series of connected venation types, beginning with *Monogramma* at the lower end of the series, and ending doubly, on the one hand with *Polytaenium*, *Anetium*, and *Ananthacorus*, and on the other hand with *Antrophyum*. The *Polytaenium* type is connected with *Monogramma* through *Vittaria*. The *Antrophyum* type, it was noted, may, according to resemblances afforded by various mature species, be derived directly from the *Hecistopteris* type without the intervention of vittarioid or twin net types. If I have presented the facts clearly, it has been made apparent that the tribe offers a completely connected series of venation patterns ranging from the uninervate *Monogramma* type to the well-developed areolate system in *Polytaenium* and the others.

This series is even more clearly demonstrated in the ontogenetic stages of certain species of the more advanced genera, and I wish now to point out in detail just how exactly the ontogenetic series agrees with the series shown by the mature plants.

I have been able to obtain young sporophytes of five species, viz., *Vittaria remota*, *V. intramarginalis*, *Polytaenium lanceolatum*, *Ananthacorus angustifolius*, and *Antrophyum reticulatum*. The *Vittaria remota* material was obtained from plants grown at the New York Botanical Garden from spores brought from Jamaica,

by accident, with a lot of filmy ferns. Plants were obtained in all stages of maturity, so that identification was easy. The plants of *Polytaenium lanceolatum* were grown from spores taken from herbarium material collected in Cuba by Mr. Norman Taylor. Planted a month or so after collection, they germinated rather slowly and remained in the prothallial stage for a couple of years before developing sporophytes. None of these were brought to maturity, so that absolutely certain identification is not practicable, but the spores were sown in sterilized soil, the prothallia showed the peculiarities of the tribe as described by Goebel and by Britton & Taylor, and their continuity for the two years and their final production of the young sporophytes figured is indubitable.

The young plants of the other three species were obtained from material collected in the field. The *Vittaria intramarginalis* material was found on an herbarium sheet showing all stages up to maturity. That of *Ananthacorus* was obtained in like manner but lacks the very young stages. The material of *Antrophyum* was collected for me by Dr. C. B. Robinson, together with mature fruiting plants of the same species. This also lacks the earliest stages. This collection included numerous young plants of some other net-veined fern, but the venation type was entirely distinct from that of *Antrophyum* and easily separable.

During the course of my work I made an attempt to grow plants of *Antrophyum reticulatum* from spores obtained from herbarium material sent me by Dr. E. B. Copeland, but the spores proved inviable after their weeks of passage from the Philippines to New York City.

My first clue to the possible significance of the ontogenetic stages was obtained from figures of young *Vittaria lineata* (L.) J. E. Sm., published by Mrs. Britton and Miss Taylor.* This species, as it appears, is similar in its young stages to *V. remota* figured here.

Before proceeding to take up the description of the young material of the five species just noted, I wish to recapitulate in detail the venation series observed in connection with the study

*Britton, E. G., & Taylor, A. Life history of *Vittaria lineata*. Mem. Torrey Club 7: 185–211. *pl. 28.* 1902.

of the mature sporophytes, and designate, by the name of the species best representing it, each successive stage of the series. This will then serve as a basis for the comparison of the ontogeny of each species.

MONOGRAMMA DAREICARPA Hook. (PLATE 3, FIG. 1)

The adult series begins with *Monogramma dareicarpa*, the simplest species in the whole tribe, the venation of which is a simple vein through the middle of the leaf. *M. graminea* has the same type of venation but is a larger plant, so *M. dareicarpa* may better serve as a starting point.

MONOGRAMMA SUBFALCATA Hook. (PLATE 3, FIG. 6)

This species presents a second stage in the venation series. As will be shown later, it probably represents a simple dichotomy of the leaf trace, modified to form the areola so characteristic of the venation of the tribe. *M. trichoidea* seems to belong here, but its structure is somewhat in doubt. *M. paradoxa* shows both this type and that of the third and next stage of venation.

VITTARIA SIKKIMENSIS Kuhn (PLATE 5, FIG. 18–20)

In *V. sikkimensis*, the leaf trace commonly divides twice to form two areolae, that is, a median vein with two lateral veins which anastomose anteriorly. This is in essence the venation of the genus *Vittaria*, but the latter may be better typified by a somewhat more advanced species.

VITTARIA INTRAMARGINALIS Baker (PLATE 5, FIG. 1)

This same type of venation is presented in characteristic form by a smaller species, *V. minima*, but I have chosen *V. intramarginalis* because it furnishes such a good transition to the next higher type. Within *Vittaria* the two divergent venation patterns might well be designated the *V. remota* and the *V. lineata* types; these are, respectively, the type with divergent areolae (PLATE 5, FIG. 11; also FIG. 7 and 10), and that with longitudinal areolae (PLATE 5, FIG. 1).

POLYTAENIUM QUADRISERIATUM Benedict (PLATE 7, FIG. 8)

Polytaenium quadriseriatum resembles *Vittaria intramarginalis* even more closely than the venation patterns might indicate.

This is shown in the figures of the cross-sections of the leaf. (Compare PLATE 5, FIG. 6, with PLATE 7, FIG. 9, 10.)

POLYTAENIUM CAYENNENSE (Desv.) Benedict (PLATE 6, FIG. 1)

Polytaenium cayennense merely represents the twin net venation in its complete development. All stages between it and *Polytaenium quadriseriatum* are presented by other species of the genus (PLATE 7, FIG. 3–6), and the same type is characteristic of *Ananthacorus* (PLATE 2, FIG. 3) and *Anetium* (PLATE 2, FIG. 1).

The two remaining genera offer venation patterns which at first sight appear to find no place in the series just presented, but represent rather a divergent series. Their exact relationship can be best shown when the ontogenetic stages are taken up. Their types may be designated sufficiently by the generic names alone.

HECISTOPTERIS J. Smith (PLATE 4)

PLATE 4 includes so many divergent leaf forms that it might at first sight appear advisable to employ more than one type name to characterize the different developments. These, however, all depend merely on the number of divisions of the leaf trace and are not recognized as distinctive of species, so that the number of types would be a matter of arithmetic. The *Hecistopteris* type then may be considered as including all forms that show a free-veined dichotomy of the leaf trace. It should be noted in passing that such *Hecistopteris* leaves as are represented by FIGURES 19, 20, and 22, of PLATE 4 are exactly analogous, as to the stage of development, with the *Monogramma subfalcata* stage. Similarly, the *Vittaria sikkimensis* stage is well represented in *Hecistopteris* by FIGURES 2, 9, and 15 of PLATE 4.

ANTROPHYUM Kaulf.

The *Antrophyum* type of venation is essentially that of *Hecistopteris*, but with the veins anastomosing to form areolae. This can be easily understood by comparing the venation of *Antrophyum nanum* (PLATE 2, FIG. 6) with that of some of the larger *Hecistopteris* leaves (PLATE 4, FIG. 4). In the larger species of *Antrophyum* the contiguity of the numerous veins so modifies the scheme as to make the dichotomy hard to trace. This modifi-

cation is sometimes accompanied by a prolongation of the leaf trace to form a partial midvein, thus approaching the *Polytaenium* type.

The ontogenetic stages of the several species to be described may now be compared in detail with the series of stages derived from mature plants, which has just been outlined.

VITTARIA REMOTA Fée (PLATE 8, FIG. 12–19)

FIGURES 12 and 13 represent clearly the *Monogramma dareicarpa* stage (PLATE 3, FIG. 1). FIGURE 14 is just as clearly like *M. subfalcata* (PLATE 3, FIG. 6), and FIGURE 15 is the next stage, that of *Vittaria sikkimensis* (PLATE 5, FIG. 18–20). FIGURES 16, 18, and 19 show an easy transition to the typical development of *Vittaria* through the *V. intramarginalis* stage to the stage typical of *V. remota* and others. FIGURE 17 is an abnormality, and FIGURE 19 shows another abnormality in having three incomplete lateral veins.

VITTARIA INTRAMARGINALIS Baker (PLATE 8, FIG. 1–11)

Vittaria intramarginalis, like *V. remota*, also starts with the *Monogramma dareicarpa* stage and attains finally to a mature *Vittaria* type, but it shows several very interesting intermediate stages. FIGURES 3–5 are like the corresponding stages of *V. remota* (FIG. 14, 15), i. e., they show once and twice forked veins, but the branches do not anastomose, hence the stages are to be compared with *Hecistopteris* rather than with *Monogramma subfalcata* and *Vittaria sikkimensis*, respectively. (Compare PLATE 8, FIG. 3–6, with PLATE 4, FIG. 1, 21, 22; 2, 9, 15; 3, 5, 10, 18, 20). FIGURE 7 (PLATE 8) should be compared with FIGURE 5 of the same plate as showing how the free-veined *Hecistopteris* type may be modified to form the *Vittaria* type. FIGURES 8–10 are somewhat aberrant leaves representing intermediate stages between the leaf illustrated in FIGURE 7 and the mature *Vittaria* type as illustrated in FIGURE 11.

POLYTAENIUM LANCEOLATUM (L.) Kaulf. (PLATE 8, FIG. 29–40)

Polytaenium lançeolatum also starts with the uninervate *Monogramma dareicarpa* stage (FIG. 38–40). FIGURE 39 shows an

abnormality in the vein unrelated to the real branching plan. FIGURES 35–39 are apparently on the same plane, but it is very interesting to find in one species that both the free-veined (FIG. 35, 37) and the areolate (FIG. 36) types may occur. It probably indicates, as was suggested earlier, that in the ontogeny of the higher genera of the Vittarieae there is not much difference between the free-veined *Hecistopteris* and similar areolate stages.

In the higher stages, *Polytaenium lanceolatum* is significant as showing the very early predominance of an axial vein. FIGURES 33, 32, 31, and 30 show successive stages in the venation development. FIGURE 29 is abnormal. FIGURES 30 and 31 are essentially analogous to the *Vittaria intramarginalis* stage. No later stages were obtained for this species, but these are probably like those figured in connection with *Ananthacorus*.

ANANTHACORUS ANGUSTIFOLIUS (L.) Und. & Maxon (PLATE 8, FIG. 20–23)

The earliest leaves of this species were not obtained, the youngest found being in the *Vittaria* stage. (See FIG. 23, 24.) FIGURES 20 and 21 show, however, how the *Polytaenium* type of venation may be developed from the *Vittaria* type. As the mature venation of *Ananthacorus* is like that of *Polytaenium* and *Anetium*, it is safe to assume that these genera follow a similar course in their ontogeny.

One relationship, already briefly referred to, stands out as particularly important, i. e., the homology existing between the costal areolae in *Polytaenium* and the only areolae in *Vittaria*. (Compare FIG. 20–23 with FIG. 11, etc.) The secondary areolae in the *Polytaenium* type arise evidently by the unequal dichotomy of the veinlets forming the costal areolae, and as each of these usually divides twice, the relation between the size of the successive areolae is naturally, as already noted, approximately 1 : ½ : ¼, except as modified by divergence from the midvein.

ANTROPHYUM RETICULATUM (Schk.) Kaulf. (PLATE 8, FIG. 24–28)

Perhaps the best evidence as to the generic distinction of *Antrophyum* and *Polytaenium* is afforded by their ontogeny as figured. The earliest stages of *Antrophyum* were not obtained

but there is no reason to suppose these would differ from those already described for other species of the Vittarieae; it probably passes through a similar *Monogramma dareicarpa* stage. Very likely, too, a second *Hecistopteris*, i. e., free-veined stage occurs. But in no further stage, if *A. reticulatum* may be taken as typical, is *Antrophyum* like either *Vittaria* or *Polytaenium* (PLATE 8, FIG. 24–28).

If the ontogenetic series may be accepted as historically accurate, *Antrophyum* is derived perhaps from a form like *Hecistopteris* and is "contemporaneous" with *Vittaria*, which probably had a like origin. *Polytaenium*, on the other hand, passes through a *Vittaria* stage, and is thus not only on a line divergent from that of *Antrophyum*, but is also of a "later" generation.

It may be objected that the ontogeny of one species is slight evidence upon which to base conclusions for a genus containing upwards of twenty-five species. This is a valid objection, but it is counterbalanced in this case by the mass of supporting evidence already adduced, derived from the mature plants.

MONOGRAMMA and HECISTOPTERIS

I have no data for the ontogeny of *Monogramma* and none for *Hecistopteris*, unless perhaps some of the smaller leaves of the latter genus figured (PLATE 4, FIG. 1 and 22) represent juvenile stages. There is little likelihood, however, that these two genera pass through growth stages of a type distinct from the ordinary type seen in the other genera.

Hecistopteris probably begins, as indicated by the two figures just noted, with a uninervate *Monogramma dareicarpa* stage and proceeds then by simple dichotomy to the characteristic free-veined condition of its mature leaves. In *Monogramma* it is hardly possible that the two simplest species, *M. dareicarpa* and *M. graminea*, are ever anything but uninervate. It would be interesting to see, however, whether the larger species pass through a free-veined *Hecistopteris* stage before reaching the mature areolate condition.

IV. GENERAL CONSIDERATIONS

In the foregoing pages, I have endeavored to describe the mature sporophytes and the ontogenetic stages of the Vittarieae

without speculation as to their significance. But because of the facts presented, three questions stand out as of especial interest.

First, what are the probable relationships of the Vittarieae? Second, what is the significance of the simple type in *Monogramma*? Third, what evidence as to the theory of recapitulation is offered by the parallel venation series seen in the mature sporophytes and in the growth stages of the more advanced genera?

1. RELATIONSHIPS OF THE VITTARIEAE

Before considering the possible relationships of the tribe, it should be emphasized that only those characters in which all the genera agree, or which appear regularly in the more primitive genera, may be used for comparison. This fact may seem too self-evident to need stating, but its disregard has led to some erroneous comparisons, of which I have contributed one in comparing *Antrophyum* with *Loxogramma* Presl of the tribe Polypodieae.*

The characters in which all the genera agree are found in the arrangement of the sporangia, in the type of rootstock scales, and in the presence of the differentiated epidermal idioblasts. Goebel found that the prothallia of a number of species in *Vittaria*, *Hecistopteris*, and *Monogramma* are of a peculiar type characteristic of the tribe. E. G. Britton and A. Taylor added *Vittaria lineata* to the list of species known to show the specialized type of prothallium, and I have found the same specialized sort in *Polytaenium lanceolatum* and in *Vittaria* (*Radiovittaria*) *remota*, two groups for which the gametophyte has not before been noted. Now there remains only to show that this type is characteristic also of *Antrophyum*, *Ananthacorus*, and *Anetium*, in order to demonstrate beyond a doubt that it is a tribal character. One other character may be included here as characteristic of the Vittarieae generally, viz., the uniformly parenchymatous structure in all parts except the vascular bundles.

Of these characters, the first two mentioned offer the best basis of comparison with other fern tribes, and furthermore both seem to indicate similar relationships. The resemblance in the sporangial arrangement to that which obtains in the Pteridieae

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*Bull. Torrey Club 34: 445. 19 O 1907.

is very obvious and probably justifies their juxtaposition in a systematic arrangement, as in Diel's treatment of the ferns in Engler and Prantl, Die Natürlichen Pflanzenfamilien. But there are also in the tribe Asplenieae similar and almost as obvious resemblances and it is not unlikely that here also some not very distant relationship is indicated.

The presence of clathrate scales in both the Pterideae and Asplenieae is further indication of a relationship. The use of scale characters in the classification of ferns is amply justified from taxonomic practice and experience (see Christensen, Am. Fern Journal 1: 36. 13 F 1911), and it is also justified on a priori grounds. Thus, it would seem reasonable to suppose that one type of scale may serve the purpose of protection about as well as another of the same size, and that if there are differences found, these represent not adaptive but orthogenetic tendencies. It follows that similarity in scales may usually be attributed to similarity in phylogeny.

The other three tribal characters mentioned are probably more distinctive of the Vittarieae than indicative of relationships.

As characters which appear regularly in the more primitive genera of the tribe, there may be mentioned, first, the presence of paraphyses, second, the production of the sporangia in grooves.

Both of these characters appear significant because they are all but general for the tribe; but whether they have any value in determining relationships may well be questioned, since both appear to be so definitely connected with the same function, that of protecting the developing sporangia. There is, however, strong suggestion of similar indusial developments in some of the Asplenieae, Pterideae, and Davallieae.

A character which is also of almost general occurrence in the tribe, but which cannot be considered of value in determining relationships with other tribes, is found in the reticulate venation, true for all but the three most primitive species. Ferns in general are usually believed to have sprung from primitively dichotomously veined forms and it has been shown that the present tribe is probably no exception in that respect, but the venation types above the dichotomous stage, i. e., *Vittaria*, etc., must be recognized as having been evolved independently, no matter if exactly

similar to venation patterns found in other tribes. For example, the twin net type of venation, as in *Polytaenium*, which is not uncommon in other tribes of ferns, cannot be used as a basis for comparison but must be considered as of independent origin in each tribe.

2. SIGNIFICANCE OF MONOGRAMMA

The significance of *Monogramma* is a difficult problem to solve. On the assumption of a dichotomously veined leaf as generally primitive for ferns, first stated by Goebel, I believe, *Monogramma* and the whole tribe Vittarieae might be considered as the affirmative exception to the rule. But here a difficulty presents itself, since the other genera appear usually to pass through a dichotomous stage following the uninervate beginning. The uninervate type must then either be recognized as more primitive than the dichotomous type or else as a derived condition in this tribe. Study of the first leaves of other simple-leaved ferns is needed.

The marginal position of the sporangia in *M. dareicarpa* and *M. graminea* is in agreement with Bower's suggestion as to the probable primitive condition for ferns. It is interesting to note here that the attainment of the dorsal position in the other genera is a direct consequence of the branching of the veins, since all or any of the veins appear to be potentially sporangiferous. Bower assumes, however, a primitively divided type with only marginal or submarginal sori, the dorsal position having been attained by the migration of the sori. In this hypothetical primitive type the sporangia are assumed to have been definitely localized in sori, not as in the present case in lines of indeterminate length. The present tribe is interesting in this respect because it offers an instance of the development of an approach to a soral condition (as in *Anetium*) from an indeterminate development of lines of sporangia.

But whatever the phylogenetic significance of *Monogramma*, its position, at least as regards two of its species, as the simplest of known vascular plants can scarcely be questioned. The leaf structure is analogous in its simplicity to that of the lycopods generally. The stele, it may be noted, as far as I have been able to determine from sections of soaked herbarium material, is a very

simple protostele in three of the species, *M. dareicarpa*, *M. subfalcata*, and *M. trichoidea*. In these the xylem strand is only a few cells thick. In *M. paradoxa* the stele is a simple siphonostele with a tiny ring of xylem and with the phloem apparently only outside.

Monogramma may well be considered as the "*Amphioxus*" type for vascular plants, and as such deserves thorough study and a place in any future course in the comparative morphology of vascular plants.

3. EVIDENCES OF RECAPITULATION IN THE VITTARIEAE

In a paper entitled "Juvenile kelps and the recapitulation theory,"* R. F. Griggs has drawn attention to the fact that botanists have generally accepted and applied the theory of recapitulation to interpret plant phylogeny without attempting to test its truth. Griggs directed attention also to the objections that have been raised against the theory by several zoologists. In his study of the kelps, he reached the conclusion that these objections are not well founded and that there is shown by these plants distinct evidence of recapitulation. I wish here to consider briefly the case of the parallel venation series furnished by the Vittarieae, in order further to test the application of the recapitulation theory.

Most of the objections appear to be built around the assumption that, since whenever a new species is produced its germ cells must contain the means of reproducing the new character, the whole ontogenetic history of a new form is on this account necessarily different from that of the parent form. Those who accept this assumption explain parallel series as due to necessity, that is, the organism in its growth repeats stages like the adult forms of its ancestors because such stages are structurally or physiologically necessary. According to this objection it should be necessary only to show that in some cases the ontogeny repeats stages that are not necessary to the attainment of the later form.

Griggs described stages in the growth of certain of the kelps, to which the argument of necessity would not seem to apply. Numerous such examples have been noted in the animal kingdom and there appears to be another well-defined example of a similar

*Am. Nat. 43: 5–30; 92–106. 1909.

inheritance of an unnecessary juvenile character in some of the ferns treated here.

There is no evidence of the repetition of an unnecessary character in the development of the twin net type of venation from that of *Vittaria*. It is impossible in this group to conceive of the higher type being developed from the simpler in any way but by the addition of secondary areolae along the previously formed costal areolae of the *Vittaria* stage. Similarly there is no evidence in the series found in *Vittaria remota* to show that any unnecessary stages were passed through here.

But when the ontogeny of *Vittaria remota* is compared with that of *V. intramarginalis* a striking difference is to be noted. Both finally reach the same venation type, the only difference being that *V. remota* carries this type to a greater specialization than is found in the other *Vittaria*. In its ontogeny, however, *V. intramarginalis* passes through a free-veined stage like the mature condition of *Hecistopteris*, a stage which, as compared with the course of growth in *V. remota*, can hardly be considered otherwise than unnecessary.

It has already been noted that *Vittaria intramarginalis* is to be considered lower in the evolutionary scale than *V. remota*, and this conclusion accords exactly with the differences in the ontogeny. Naturally the more primitive species would longer retain unnecessary ancestral characters.

SUMMARY

Several conclusions from the above study seem to deserve the emphasis of a repetition in the summary.

1. The Vittarieae represent a well-defined, rather specialized natural group of ferns probably related to the Pterideae and to the Asplenieae. Seven genera are to be recognized, *Monogramma* Schk., *Hecistopteris* J. Sm., *Vittaria* J. E. Sm., *Polytaenium* Desv., *Ananthacorus* Und. & Maxon, *Anetium* Splitg., and *Antrophyum* Kaulf.

2. The genus *Monogramma* includes two species, *M. dareicarpa* Hook. and *M. graminea* (Poir.) Schk., which seem to possess the simplest leaf and stem structure known among vascular plants.

3. The seven genera may be arranged according to their vena-

tion patterns in a phylogenetic series beginning with *Monogramma* and ending doubly, with *Anetium* on the one hand, and with *Antrophyum* on the other.

4. The more advanced genera show in their ontogeny successive venation stages similar to those noted in the phylogenetic series.

5. The species whose ontogenies were studied differ from most ferns in beginning with a uninervate type, but usually they show secondarily the free dichotomous venation found in other ferns.

6. The tribe illustrates clearly how one type of areolate venation may have been derived from a free dichotomous type.

7. In comparing the parallel adult and ontogenetic venation series, affirmative evidence for the theory of recapitulation is found in the inheritance in at least one primitive species of *Vittaria* of an unnecessary juvenile stage which in another more advanced species of *Vittaria* has been eliminated.

COLUMBIA UNIVERSITY.

Explanation of plates 2–8

PLATE 2. Illustrating tribal characters

FIG. 1. *Anetium citrifolium;* portion of leaf, natural size, showing venation and arrangement of sporangia; from *von Tuerckheim 9625*, Guatemala.

FIG. 2, 3. *Ananthacorus angustifolius;* 2, cross-section of leaf, × 12, showing sporangial grooves; 3, portion of leaf, natural size, showing venation and arrangement of sporangia; both *Underwood & Earle 1175*, Cuba.

FIG. 4, 5. *Vittaria minima;* leaves, natural size, to show venation and arrangement of sporangia; 4, *Wercklé*, Costa Rica (type material of *Hecistopteris Werckleana* Christ); 5, *Enares*, Costa Rica (type material of *Antrophyum minimum* Baker).

FIG. 6. *Antrophyum nanum;* single plant, natural size, showing venation and arrangement of sporangia; from *R. S. Williams 2826*, Philippines.

FIG. 7, 8. *Monogramma paradoxa;* a, spicular cells (after Luerssen).

FIG. 9, 10. *Vittaria stipitata;* rhizome scales; 9, *H. H. Smith 1112*, Santa Marta, Colombia; 10, *Wercklé*, Costa Rica.

FIG. 11–16. *Vittaria scabrida* (?); *W. R. Maxon 3313*, Guatemala; 11, rhizome scale, × ca. 75; 13, spore much enlarged; 12, 14–16, paraphyses, much enlarged.

FIG. 17–22. *Vittaria remota; R. S. Williams 889*, Panama; 17, rhizome scale, × ca. 75; 18–20, paraphyses, much enlarged; 21, 22, spores.

FIG. 23–25. *Antrophyum semicostatum, R. S. Williams 2054*, Philippines; 23-24, paraphyses, much enlarged; 25, spore, much enlarged.

PLATE 3. *Monogramma*

FIG. 1–3. *M. dareicarpa; E. B. Copeland 63*, Negros, Philippines; 1, leaf showing venation, × 2; 2, cross-section of leaf to show sporangial groove, × 12; 3, whole plant, natural size.

FIG. 4, 5. Paraphyses of the *M. graminea* type, much enlarged.

FIG. 6–8. *M. subfalcata;* after Hooker, Sp. Fil. 5: 122. *pl.* 289 *a.* 1864, showing venation; 6, section of leaf; 7, habit of plant; 8, enlargement as in *M. dareicarpa.*

FIG. 9–11. *M. trichoidea;* illustrating same features as preceding species; enlargements the same; 9, *E. B. Copeland 1723*, Mindanao; 10, 11, *R. S. Williams 2230.*

FIG. 12–15. *M. paradoxa*; showing venation (12 and 13) and leaf sections (14 and 15), the sections having been taken at about the positions indicated on FIG. 13; 12, *R. S. Williams 1492*, Luzon; 13–15, *Bolles*, Samoa.

FIG. 16–18. Paraphyses (16 and 18) and spore (17) of *M. paradoxa.*

FIG. 19, 20. *M. graminea;* showing venation and leaf section; enlargement as in similar figure preceding.

PLATE 4. *Hecistopteris*

FIG. 1–22. Showing leaf outlines, venation, and arrangement of sporangia (7 and 17); sporangia present but not indicated on most of the other leaves; enlargement in all cases × 2. 1–8, *R. S. Williams 1159*, Bolivia; 9–12, *Jenman*, Kara Kara Creek, British Guiana; 13–15, *Jenman*, Essequibo River, British Guiana; 16–18, *Jenman*, Trinidad; 19–22, *R. S. Williams 1172*, Bolivia.

PLATE 5. *Vittaria*

FIG. 1–6. *V. intramarginalis; Underwood & Earle 875*, Cuba; 1, leaf, showing venation, ×2; 2–5, cross-sections of petiole showing double leaf trace at base (2, 3) and its fusion to form single midvein (4, 5); 6, cross-section of lamina at about the middle to show sporangial grooves; all sections enlarged 12 times.

FIG. 7, 8. *V. scolopendrina; 7, E. D. Merrill 5861*, Mindoro; 8, *Bolster 308*, Mindanao; 7, portion of leaf, × 2, showing venation; 8, cross-section from midvein to margin, ×12, showing sporangial groove.

FIG. 9, 10. *V. "elongata"; Copeland 1516*, Mindanao; 9, cross-section of leaf, ×12, showing sporangial groove; 10, portion of leaf, ×2, showing venation.

FIG. 11–17. *V. remota; R. S. Williams 889*, Panama; 11, portion of leaf, ×2, showing venation; 12, cross-section of leaf blade, ×12, showing very slight sporangial groove; 13–17, cross-sections of petiole from base to beginning of blade, ×12, showing a single leaf trace.

FIG. 18–21. *V. sikkimensis, A. Henry 10489*, Szemao, China; 18–20, leaves, × 2, showing venation like that of large *Monogramma paradoxa* (PLATE 2); 21, cross-section of leaf × 12, showing two separate sporangial grooves characteristic of *Vittaria.*

PLATE 6. *Polytaenium* and *Antrophyum*

FIG. 1. *Polytaenium cayennense; Fendler 151*, Trinidad; leaf slightly reduced in size, showing twin net type of reticulate venation.

FIG. 2. *Antrophyum plantagineum; R. S. Williams 2444*, Mindanao; leaf slightly reduced in size, showing single net type of reticulate venation.

PLATE 7. *Polytaenium* and *Antrophyum.*

FIG. 1, 2. *Antrophyum stenophyllum; A. Henry 9607*, Szemao, China (type number, first time illustrated); 1, whole plant, ×½, showing arrangement of sporangia; 2, leaf, ×½, showing venation.

FIG. 3–5. *Polytaenium lanceolatum* var. *Feei;* Mexico; 3, *H. Fink 115;* 4 and 5, *F. Müller;* leaves ×½, showing venation and arrangement of sporangia.

FIG. 6. *Polytaenium discoideum; R. S. Williams 1355*, Bolivia; leaf, ×½, showing venation and arrangement of sporangia.

FIG. 7. *Antrophyum Williamsi* Benedict (see Am. Fern Jour. 1: 70. 1911); *R. S. Williams 1579*, Luzon; plant, ×½, showing arrangement of sporangia in lines, as in middle leaf, and their apparent confluence at maturity.

FIG. 8–10. *Polytaenium quadriseriatum* Benedict; *Nash & Taylor 1360*, Hayti, type; 8, leaf, natural size, showing venation and arrangement of sporangia; 9, 10, cross-sections of leaves, ×12, showing sporangial grooves.

PLATE 8. Ontogenetic stages

(All figures except 19 twice natural size)

FIG. 1–11. *Vittaria intramarginalis; Underwood & Earle 875*, Cuba.

FIG. 12–19. *Vittaria remota;* from plants grown at the N. Y. Botanical Garden, spores from Jamaica; 19, natural size.

FIG. 20–23. *Ananthacorus; Underwood 2767*, Jamaica.

FIG. 24–28. *Antrophyum reticulatum; C. B. Robinson*, Bureau of Science, *9915*, Luzon.

FIG. 29–40. *Polytaenium lanceolatum ;* from plants grown at the N. Y. Botanical Garden, spores from Cuba (*Taylor*).

The caulescent violets of the southeastern United States

Ezra Brainerd

Of the twelve indigenous species of stemmed violets in the eastern United States, ten occur in the states covered by Dr. Small's Manual, but only one of the ten, *Viola tripartita*, is restricted to this region. Four of the ten are northern species, that find a congenial habitat in the South only in the Appalachian Mountains or foothills.

The caulescent species of *Viola* east of the Rocky Mountains are not as difficult to the student of systematic botany as are the acaulescent species. This is due largely to the fact that the species are fewer and less frequently hybridize with each other, and consequently do not present in the field so many perplexing intermediate forms. The early students of the genus were thus able to present a more accurate account of these species. Indeed their treatment by Schweinitz in 1822 is in most particulars confirmed by recent researches. His chief fault was the common one of his age, a disregard of the claims of priority in the naming of species, so that five of the eleven southern forms are presented under untenable and often misleading names. But his Latin descriptions are so full and accurate, that a careful reading leaves no doubt as to the plant he had in mind, and shows that his work was so thorough and discriminating that after nearly ninety years not a single indigenous species or variety needs to be added to his list.

The ten southern species fall naturally into three sections, readily distinguished by differences in styles and stipules. The first section is marked by a capitate style and by stipules nearly entire and soon scarious; it comprises the four yellow violets and *V. canadensis*.

Viola hastata Michx. is in several respects unique among the yellow caulescent violets. The dilated basal lobes are broadly rounded, not acute as in the strictly hastate leaf; so that the blade

is shaped more like a halberd, or an ancient battle-ax, than a spearhead. The upper surface is often mottled with a lighter green, due to the presence of minute air vessels in the epidermis. Several other species, *V. hirsutula*, *V. villosa*, and *V. Walteri*, have this leaf marking, especially in the South. But the most striking character of *V. hastata* is the long, white, brittle rootstock, resembling that of *Dentaria diphylla*. The other species of the section have short, woody rootstocks with coarse fibrous roots.

VIOLA TRIPARTITA Ell. has the distinction of being the only stemmed violet with cut leaves found east of the Rocky Mountains; but on the Pacific coast it is well matched by *V. lobata*. Though the specific difference between the two is pronounced, they have several characters in common besides the dissected leaves: the same coarse fibrous roots, the same purple tinge on the outside of the otherwise yellow petals, the same marked variability in pubescence, and the same fondness for the companionship of a variety with uncut leaves.

VIOLA TRIPARTITA Ell. var. GLABERRIMA (Ging.) Harper is the name now accepted for this vâriety of the eastern species. The history of the plant in systematic botany is interesting. It was first published by Schweinitz as a species, *V. striata*,* though he was well aware that the name had already been given to a different species. He describes it as very glabrous—"glaberrima"—but afterwards notes that "in a very few instances hairs were scattered on the nerves of the underside of young leaves." He says further: "Mr. Leconte first found it in our vicinity [Salem, N. C.] and directed my attention to it, and by continued observation, I am well assured of its being a very good and constant species."

Two years later, in DeCandolle's Prodromus, 1: 300. 1824, Gingins disposed of Schweinitz's *V. striata* as *V. hastata* var. *glaberrima*. This may have been at the suggestion of LeConte, for in his final paper on *Viola*, in 1826, Le Conte, without giving any credit to Gingins, treats both the *V. striata* of Schweinitz and the *V. tripartita* of Elliott as forms of *V. hastata*, adding the following remarkable statement: "*V. striata* Schwein. was formerly taken by me for a distinct species, but by culture I found that it was a mere variety, and sometimes the result of accident. In fact, if the

*Am. Jour. Sci. 5: 76. 1822.

stem of *V. hastata* is broken off when it first rises out of the ground, the root forms another stem which never bears hastate or deltoid leaves."* Among LeConte's unpublished drawings of *Viola* is one labeled *V. hastata*, bearing two stems from the same rootstock, one having the characteristic leaves of this species, and the other leaves more like those of *V. striata* Schwein. The picture impresses one as a monstrosity, and the statement as founded on a misapprehension. In my own experience in transplanting violets from the wild I have more than once been astonished at seeing incongruous leaves or capsules on what seemed the same plant, only to find on careful examination the roots of two plants of different species closely entangled. But whatever the cause, LeConte badly blundered in receding from his first judgment that *V. hastata* and Schweinitz's *V. striata* were specifically distinct, a blunder that his successors kept up for nearly seventy years, and that appears in the latest edition of Chapman's Southern Flora and the posthumous volume of Dr. Gray's Synoptical Flora. Dr. Small, in 1897,† was the first since the days of Schweinitz to make clear once more the marked specific difference between *V. hastata* and its supposed varieties.

There have recently been attempts to separate out from *V. tripartita glaberrima* (Ging.) Harper two new species: *V. glaberrima* (Ging.) House,‡ and *V. tenuipes* Pollard;§ both, it seems to me, based on mere fluctuations or trivial differences. In the original description of *V. tenuipes* the petals are said to be beardless; but in my specimens of this proposed species,|| the three lower petals are plainly bearded. The petals are also said to be quite free from markings; but in both the Auburn specimens and in the type from Chattahoochee, Fla. (seen in the Biltmore herbarium), there are brown veins on the spurred petal, as though the black lines, seen in all allied species, had simply faded out.

* *V. striata* Schweinitz olim a me pro distincta specie habita: sed a cultura inveni ut mera et interdum fortuita varietas fuisset. Revera, si caulis *V. hastatae* abrumpitur cum primum e terra prodit, radix alterum caulem fundit, qui nunquam folia hastata aut deltoidea producit." LeConte, Ann. Lyc. N. Y. **2**: 151. D 1826.

† Bull. Torrey Club **24**: 494. 30 N 1897.

‡ Torreya **6**: 172. 26 Au 1906.

§ Proc. Biol. Soc. Washington **15**: 201. 1902.

|| Greene and Pollard's No. Am. Violaceae *33*, Auburn, Ala., April 6, 1901.

VIOLA ERIOCARPA Schwein., according to present rules of nomenclature, must displace *V. scabriuscula*, only mentioned by Schweinitz as a name that he had discarded.* Its specific distinctness from *V. pubescens* has been questioned from the first. But if one had to deal only with the most pronounced forms of each, he would, I think, be quite ready to recognize two species. In regions where both occur the two types run together, as do *V. fimbriatula* and *V. sagittata*. Each species through hybridism seems to borrow at times one or more characters from the other, presenting them in a compromise or in an unmodified form. In the rich dry deciduous forests of the North one usually gets the pure forms of *V. pubescens*. South of Virginia it occurs rarely, if at all, though specimens of *V. tripartita glaberrima* Harper have been often distributed as *V. pubescens*. Accordingly, in North Carolina and in that latitude westward as far as Oklahoma, one finds the genuine *V. eriocarpa* of Schweinitz. It differs from *V. pubescens* Ait. in being nearly glabrous throughout except for its densely woolly capsules, in having several spreading stems (shorter and more leafy) and one to three radical leaves from one rootstock, and in growing in open thickets and rich meadow bottoms. This typical form is seen occasionally northward, especially in the Mississippi Valley; but the intergradient forms are more common.

VIOLA CANADENSIS L. is found in the uplands of the southern Alleghanies, and as far south as Tuscaloosa, Alabama, usually with shorter stems and smaller leaves and flowers than it has northward. The capsules have been described as glabrous in all the manuals; but they are often downy or densely puberulent, a fact that did not escape the careful observation of Schweinitz, who says: "Capsula leviter pubescente."

The second section of our stemmed violets is marked by a slender style not enlarged upward, and by green stipules with sharp often bristly teeth. In the South it is represented by four species.

VIOLA STRIATA Ait. is easily recognized by its white or cream-colored flowers, which appear in early spring, often when the stems

*In the Elliott herbarium at Charleston, S. C., is a specimen labeled "*Viola eriocarapa* m[ihi]" in the handwriting of Schweinitz. It agrees well with his description, and may serve for all practical purposes as his type.

are but half grown and decumbent. In summer when fully developed the plants may attain a height of six decimeters, and present a very different aspect. Even Schweinitz was betrayed into describing as a new species, *V. repens*,* a form found only "on the rocks of the Saura mountains." It was apparently seen only in May, as he says, "capsula non observata." This error should be placed side by side with his protest against regarding *V. clandestina* Pursh as the summer state of *V. rotundifolia* Michx.; the former with the latter, he says, "can have no affinity whatever"!† These errors would hardly deserve notice, had there not been in recent years so many similar instances, in which the protean forms of a violet have been described under several specific names.

VIOLA CONSPERSA Reichenb. is a third stemmed violet occurring southward only in the Appalachian uplands. The list is long of the various names under which it has passed. In the Britton and Brown Illustrated Flora it is described as *V. labradorica* Schrank, 1818. But this boreal plant seems distinct, being much smaller, bearing only one or two deep violet flowers on a stem, having rounded leaves and narrow stipules; the most southerly stations are the high mountains of New York and New England. Schweinitz, who received the Labrador plant from a missionary friend, named it *Viola punctata*,‡ unaware of the name Schrank had given it four years before. The common species of the northern United States Schweinitz recognizes as *V. uliginosa* Muhl.; but that name had been previously used by Schrader.

The oldest available name is that of Reichenbach, in his Iconographia botanica, seu Plantae criticae **1**: 44. *pl. 52. f. 108*. 1823. Both the description and the colored plate indicate the species unmistakably. The type specimen was sent Reichenbach by Dr. Torrey from New York under the name *V. asarifolia*, a *nomen nodum* of Muhlenberg's Catalogue, doubtless intended for the species in question. But in 1814 Pursh had published as *V. asarifolia* a plant from the mountains of North Carolina, now identified with *V. sororia* Willd. Knowing only *V. asarifolia*

*Loc. cit. 70.

†Loc. cit. 63.

‡Loc. cit. 67.

Pursh, Reichenbach correctly states that it differs greatly from Dr. Torrey's plant, which he accordingly renames *V. conspersa* (i. e., besprinkled), from the numerous minute dark dots and lines that he observed on the lower surface of the leaves. This phenomenon is often seen in herbarium specimens, not only of this, but of many other species of *Viola*, though not in the living plant. It is probably a pathological condition, caused by some bacterial activity in the tissue of plants that have been long in drying. *Viola punctata* Schwein., above mentioned, evidently got its name for a similar reason, as the "glandular punctures," which the author observed on the upper surface of the leaves, are not ordinarily present.

VIOLA WALTERI House is an allied plant which botanists have been slow to recognize as specifically distinct, and still slower properly to christen. Walter, in 1788, called it *V. canina*, but it is not the European plant so named by Linnaeus; Elliott, in 1817, placed it under *V. striata*, but it is not the species so named by Aiton; Schweinitz, 1822, called it *V. debilis*, but it is not what Michaux had called *V. debilis;* Dr. Britton, 1894, called it *V. multicaulis*, but the name had been previously used by Jordan. We may hope that *V. Walteri* has come to stay. The species, though not common, is widely distributed through the southern states from the Atlantic coast to Texas.

Viola Walteri affords an excellent illustration of the metamorphism of stems into stolons. The petaliferous flowers of early spring apparently rise from tufts of radical leaves along with ascending stems. These soon lengthen, become prostrate, and bear through the season leaves and apetalous flowers on long slender axillary peduncles. In autumn the prostrate stems are usually buried under fallen leaves, and surviving the winter send up in spring from their tips rosettes of leaves, form roots, and become new plants. In this method of reproduction *V. Walteri* closely resembles *V. odorata*, classed as a stemless violet with surface runners that bear leaves and cleistogamous flowers, as well as form new plants.

VIOLA ROSTRATA Muhl. is noteworthy for being without a synonym; its extremely long spur distinguishes it conspicuously from all other violets. Yet aside from its floral characters it

closely resembles *V. conspersa;* and in midsummer the two are easily confused. It is the fourth of the stemmed violets whose southern range is restricted to the Appalachian region.

The third and last section of stemmed violets in the southeastern United States is the one to which the European pansy belongs; it is represented in the New World by two very similar species, one introduced and one indigenous.

The latter, VIOLA RAFINESQUII Greene, is widely distributed from New York to Georgia and westward to Michigan and Texas. It so closely resembles the introduced species, *V. arvensis*, that many American botanists (even Dr. Gray) have failed to distinguish them. The native plant is much smaller and more delicate, with petals about twice the length of the sepals, those of the other species being hardly as long as the sepals.

VIOLA ARVENSIS Murr. will need to be recognized as an introduced plant in the South as well as in the North, and may become a weed in cultivated ground in America as it is in Europe. I found it last April abundant and troublesome in a field where shrubs were propagated, at Biltmore, N. C.

Synopsis of the caulescent violets of the southeastern United States

§1. Style capitate, beakless; spur short; stipules nearly entire, soon scarious. Petals yellow.

Rootstock long, thick, whitish, bearing crisp, capillary roots.	*V. hastata.*
Rootstock short, woody, brown, bearing coarse, fibrous roots.	
Petals tinged outside with violet.	
Leaves 3-lobed to 3-divided.	*V. tripartita.*
Leaves uncut, ovate or rhombic-ovate.	*V. tripartita* var. *glaberrima.*
Petals yellow outside.	
Sparingly pubescent, root leaves usually 1–3.	*V. eriocarpa.*
Markedly pubescent, root leaves usually wanting.	*V. pubescens.*
Petals white inside, usually violet outside.	*V. canadensis.*

§2. Style not capitate, slender; length of spur at least twice the width; stipules bristly toothed; somewhat herbaceous.

Spur less than 8 mm. long; lateral petals bearded.	
Petals white, or cream-colored.	*V. striata.*
Petals violet blue.	
Stems ascending; later leaves subacuminate.	*V. conspersa.*
Stems prostrate; leaves obtuse.	*V. Walteri.*
Spur 10–20 mm. long, slender, lateral petals beardless.	*V. rostrata.*

§3. Style much enlarged upward into a globose, hollow summit; stipules large, leaflike, pectinate at base.

Upper leaves entire, or obscurely crenulate; petals twice the length of sepals. *V. Rafinesquii.*

Upper leaves plainly crenate; petals usually shorter than the sepals. *V. arvensis.*

MIDDLEBURY, VERMONT.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1904–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Includes 9 new species.

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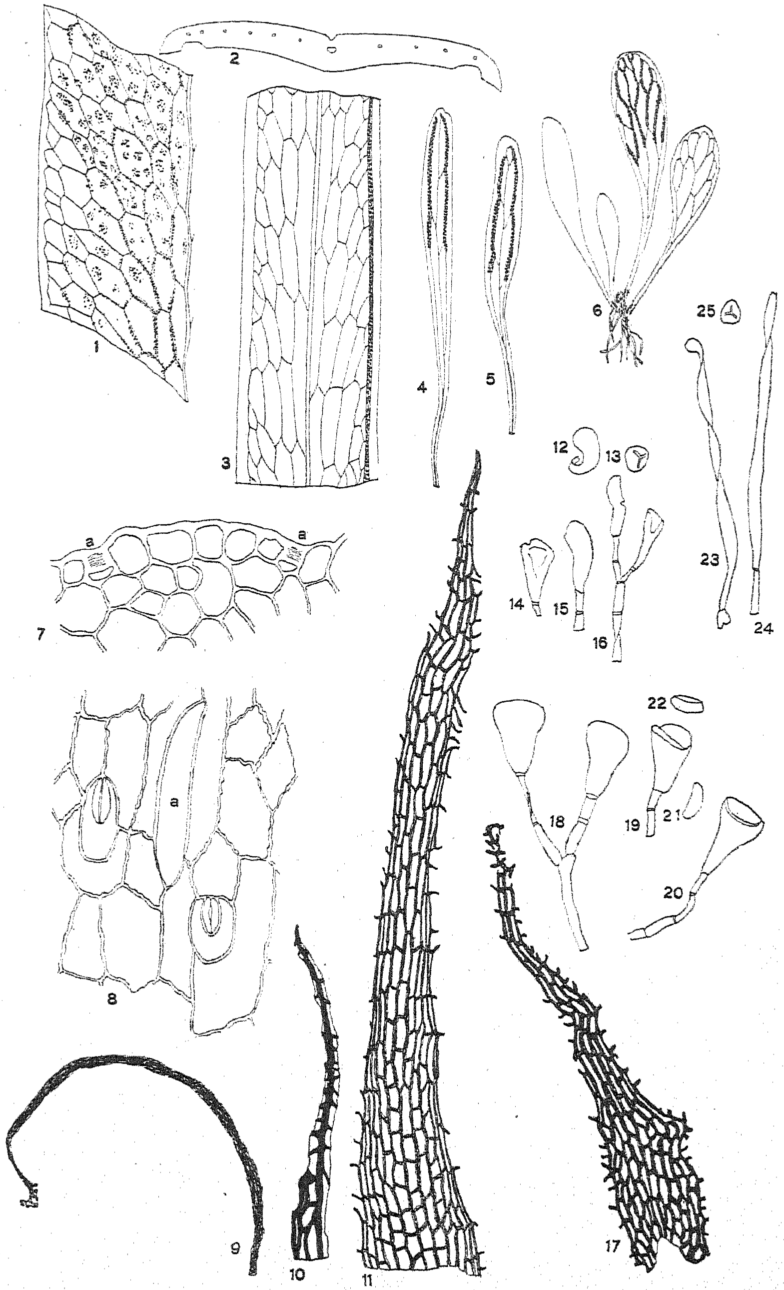
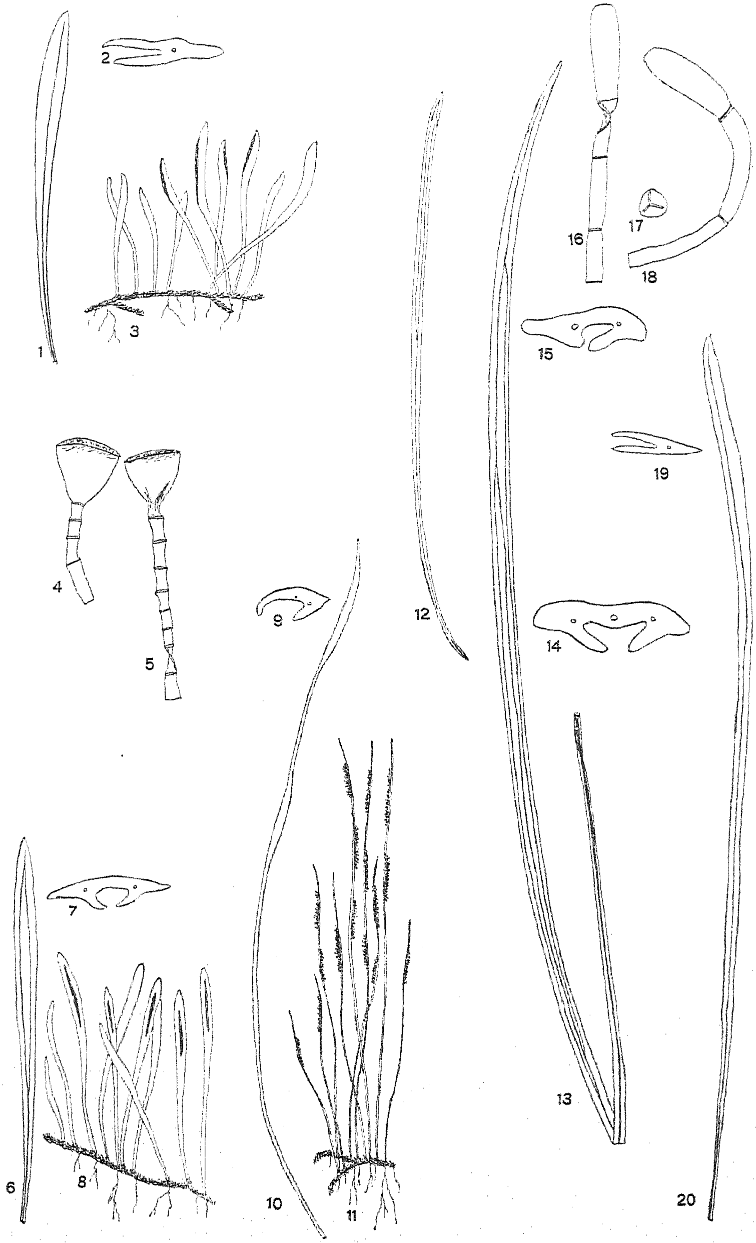
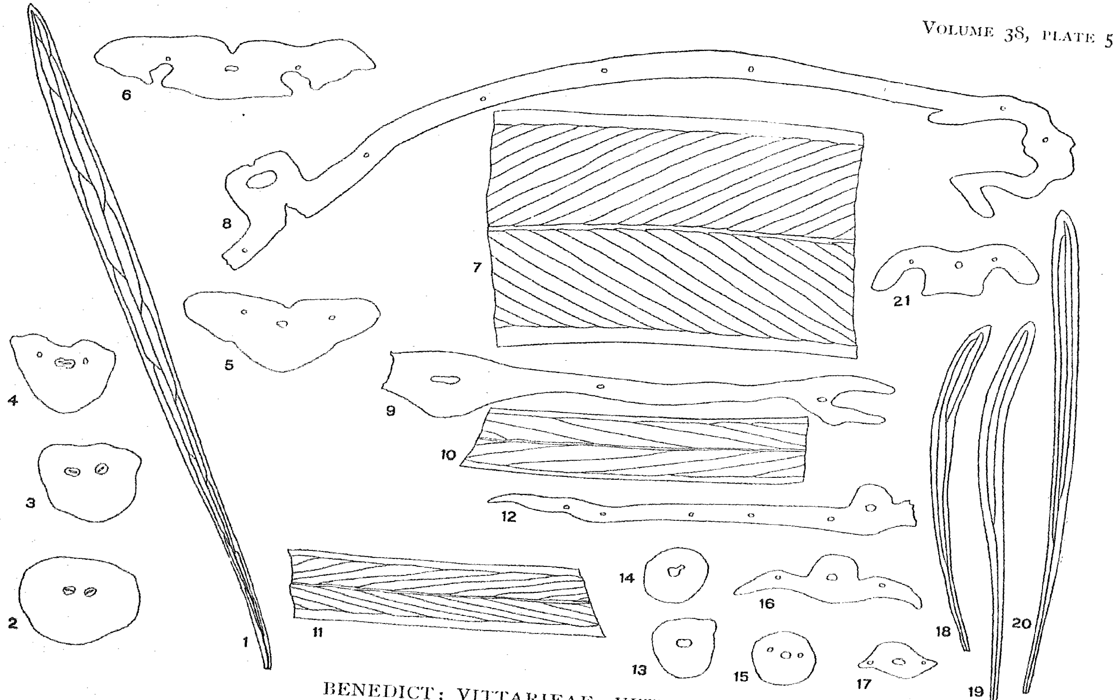


BENEDICT: VITTARIEAE, TRIBAL CHARACTERS

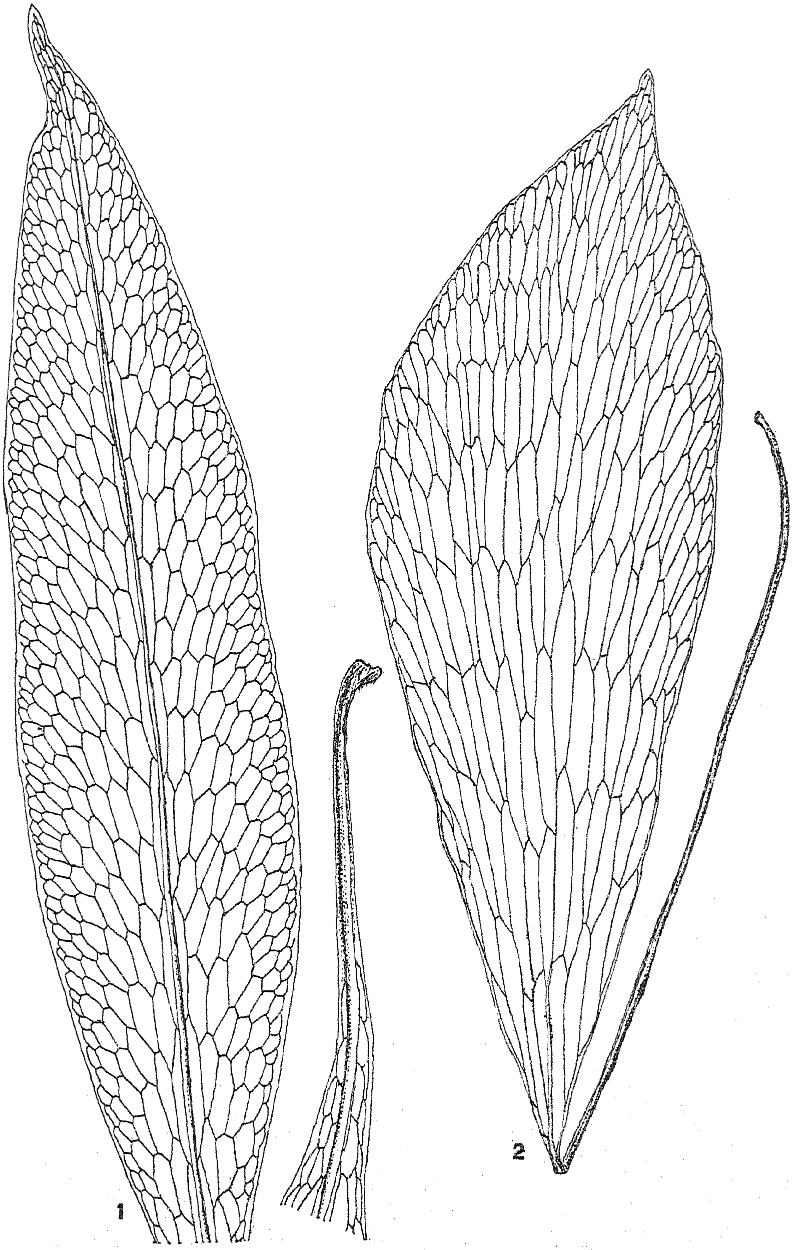


BENEDICT: VITTARIEAE, MONOGRAMMA

BENEDICT: VITTARIEAE, HECISTOPTERIS



BENEDICT: VITTARIEAE, VITTARIA



BENEDICT: VITTARIEAE, POLYTAENIUM and ANTROPHYUM

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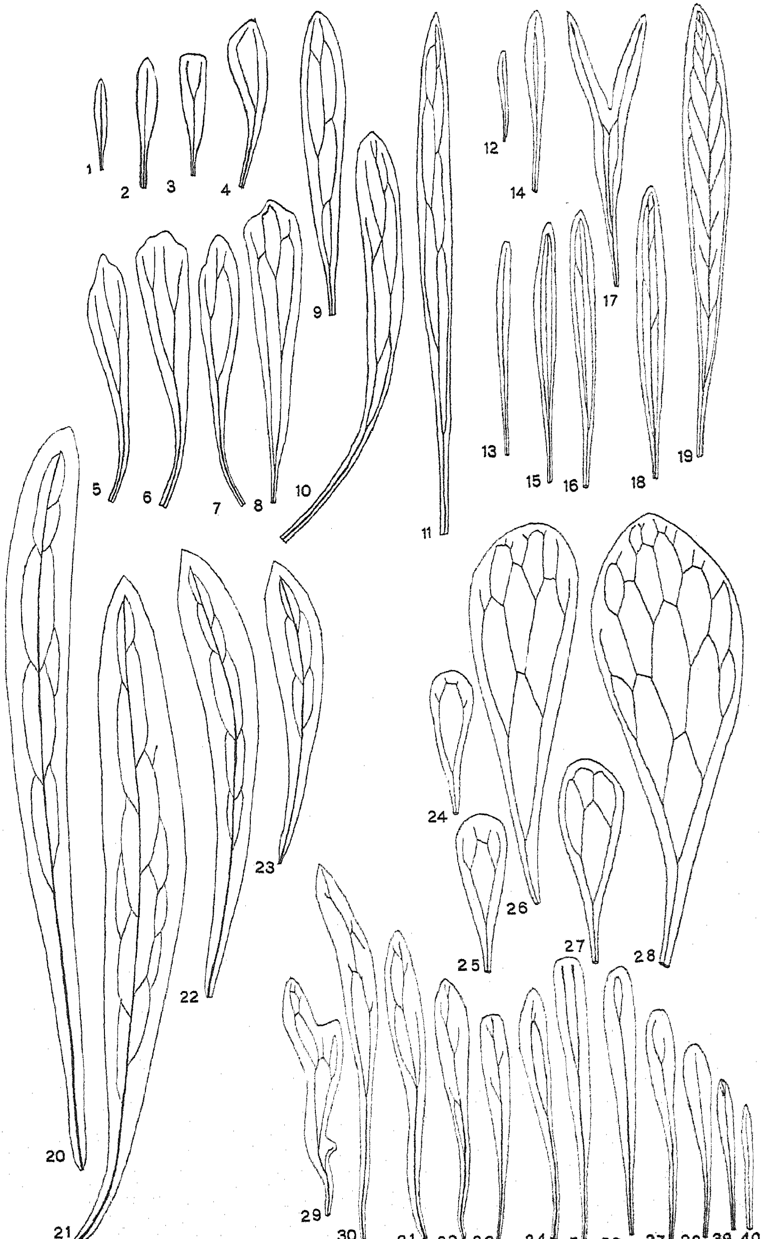

BENEDICT: VITTARIEAE, ONTOGENETIC STAGES

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The Hepaticae of the Bahama Islands

ALEXANDER W. EVANS

(WITH PLATES 9 AND 10)

Previous to 1903 no Hepaticae had been reported from the Bahama Islands. In that year a list of eight species was published by Coker* from determinations made by the writer. It was based on collections made in the vicinity of Nassau and includes six Lejeuneae and two species of *Frullania*. With a single exception the species listed are also known from Florida and all are common in the Antilles.

During the years 1904–1910 a botanical exploration of the Islands was carried on under the direction of the New York Botanical Garden. The collections made included many packets of Hepaticae and these also were sent to the writer for examination. They were found to contain twenty-six species which Coker did not list, thus raising the total number of species known from the Islands to thirty-four. Several Lejeuneae from these collections, including the new *Brachiolejeunea bahamensis*, have already been reported upon in other connections.

The most complete representation of Bahamian Hepaticae was secured by Mrs. Elizabeth G. Britton, who found twenty-six species on the island of New Providence alone. The other islands, only one of which was visited by Mrs. Britton, yielded much smaller collections, Andros leading with only eight species to its credit. It is of course probable that most of the forms now known from New Providence only are more or less widely distributed through-

* In Shattuck: The Bahaman Islands 248. 1905.

[The BULLETIN for April 1911 (38: 153–204. *pl. 2–8*) was issued 5 My 1911.]

out the group, and that others still await discovery. The collections already made, however, show clearly the general characteristics of the hepatic flora.

The present paper includes a full report on the various specimens studied by the writer. Under each species the local distribution in the archipelago is given, together with notes on the general distribution. New or otherwise noteworthy species are treated more fully than the others and, in conclusion, the relationships of the Bahamian Hepaticae to those of neighboring regions are briefly discussed. Since many of the Lejeuneae listed have recently been studied critically by the writer, references are given to papers in which descriptions of such species may be found. No attempt is made, however, to treat the synonymy at length.

RICCIACEAE

1. RICCIELLA CRYSTALLINA (L.) Warnst.

On wet ground. New Providence: Barnett's Point, *Britton & Millspaugh* (*2627*). Widely distributed in North America, Europe, and Asia.

MARCHANTIACEAE

2. MARCHANTIA CHENOPODA L.

Along a drain. New Providence: Fort Charlotte, *Brace* (*3916*). Widely distributed in the American tropics. The Bahamian specimens are gemmiparous and show neither male nor female receptacles.

JUNGERMANNIACEAE

3. PLAGIOCHILA LUDOVICIANA Sulliv.

On bark. New Providence: Maidenhead Coppice, *E. G. Britton* (*253, 3221, 6555*). Florida to Louisiana.

4. RADULA AUSTRALIS Aust.

On bark. Andros: Nicholl's Town and vicinity, *Brace* (*6880*). New Providence: Maidenhead Coppice, *E. G. Britton* (*3261 p.p.*). Georgia and Florida. Recently reported from the Bahama Islands by Stephani.*

*Species Hepat. 4: 216. 1910.

5. DIPLASIOLEJEUNEA RUDOLPHIANA Steph. Hedwigia 35: 79. 1896.

On bark. New Providence: Soldiers Road, *Coker* (*1 p.p.*), *E. G. Britton* (*819 p.p., 820 p.p., 3255 p.p.*); Waterloo, *E. G. Britton* (*3 p.p.*); Rifle Range Coppice, *E. G. Britton* (*561 p.p.*); Lake Cunningham, *E. G. Britton* (*645 p.p.*); near Tea House, *E. G. Britton* (*3193 p.p.*). Florida; tropical America. Widely distributed but often confused with *D. unidentata* (Lehm. & Lindenb.) Schiffn. The species has already been listed under this name by Coker.

6. COLOLEJEUNEA JOORIANA (Aust.) Evans, Mem. Torrey Club 8: 173. *pl. 22. f. 9–20.* 1902.

On bark. New Providence: Waterloo, *E. G. Britton* (*3 p.p.*). Crooked Island: Stopper Hill, *Brace* (*4816 p.p.*). North Carolina to Florida and Louisiana; Bermuda.

7. LEJEUNEA FLAVA (Swartz) Nees, Naturgesch. Eur. Leberm. 3: 277. 1838.

Jungermannia flava Swartz, Prodr. Fl. Ind. Occ. 144. 1788.
Lejeunea Moorei Lindb. Acta Soc. Sc. Fenn. 10: 487. 1875.
Lejeunea americana (Lindb.) Evans, Mem. Torrey Club 8: 154. *pl. 20. f. 14–26.* 1902.*

On bark. New Providence: Waterloo, *E. G. Britton* (*765 p.p.*); Maidenhead Coppice, *E. G. Britton* (*6576 p.p.*). Widely distributed in tropical regions throughout the world; Ireland; Australia; North Carolina to Florida and westward to Texas.

A specimen of *Lejeunea flava* collected by Swartz in Jamaica is preserved in the herbarium of the British Museum and is doubtless to be considered a part of the original material. It agrees closely with the plants from various North American localities, which the writer has lately referred to *L. americana*. The latter species, therefore, as indicated above, must be reduced to synonymy. The specimens distributed in Hepaticae Spruceanae under the name *Eulejeunea flava* present a somewhat different appearance, but they are not very well preserved and can hardly give a clear idea of Spruce's interpretation of the species. In

*Schiffner gives other synonyms in his Conspectus Hepaticarum Archipelagi Indici 249. 1898.

any case the epiphyllous plants which he described and distributed under the name *Eulejeunea albida* agree with Florida specimens of *L. flava* and therefore with Swartz's Jamaican specimens. It may be noted in this connection that the original material of *L. flava* was also epiphyllous, growing on the old leaves of ferns; the species, however, is even more common on bark.

8. LEJEUNEA GLAUCESCENS Gottsche.

On bark. Great Bahama: Eight Mile Rocks, *Britton & Millspaugh* (*2587*, *2609*). Cat Island: the Bight and vicinity, *Britton & Millspaugh* (*5872*, *5873*). Tropical America; Florida; Bermuda. The Bahamian specimens are not very well developed but seem to be referable to this species.

9. MICROLEJEUNEA BULLATA (Tayl.) Evans, Mem. Torrey Club 8: 164. *pl. 21. f. 20–29.* 1902.

On bark. New Providence: Soldiers Road, *Coker* (*15 p.p.*); Waterloo, *E. G. Britton* (*2*); Maidenhead Coppice, *E. G. Britton* (*3254 p.p.*); Carmichael, *E. G. Britton* (*443 p.p.*). Crooked Island: Stopper Hill, *Brace* (*4816 p.p.*). Tropical America; South Carolina; Florida.

10. MICROLEJEUNEA LAETEVIRENS (Nees & Mont.) Evans, Bryologist 11: 68. 1908.

Microlejeunea lucens (Tayl.) Evans, Mem. Torrey Club 8: 157. *pl. 21. f. 1–10.* 1902.

On bark. Abaco: Great Cistern, *Brace* (*1783*). Berry Islands: Lignum Vitae Cay, *Britton & Millspaugh* (*2325*, *2327*). Andros: near Nicholl's Town, *Small & Carter* (*8966 p.p.*). New Providence, Mt. Vernon, *Coker* (*19*); Waterloo, *E. G. Britton* (*765 p.p.*, *6629 p.p.*); Maidenhead Coppice, *E. G. Britton* (*213 p.p.*, *3216*, *3217 p.p.*, *3218*, *3252 p.p.*, *3253*, *3258*, *3259*, *6559*, *6576 p.p.*); Lake Cunningham, *E. G. Britton* (*610 p.p.*); Carmichael, *E. G. Britton* (*443 p.p.*). Cat Island: Orange Creek and vicinity, *Britton & Millspaugh* (*5711*). Widely distributed in tropical America; Virginia; Florida to Louisiana.

11. RECTOLEJEUNEA BERTEROANA (Gottsche) Evans, Bull. Torrey Club 33: 12. 1906.

Cheilolejeunea versifolia (Gottsche) Schiffn. Bot. Jahrb. 23: 597. *pl. 5. f. 1–7.* 1897. Evans, Mem. Torrey Club 8: 145. 1902.

On bark. New Providence: Soldiers Road, *E. G. Britton* (*824 p.p.*); Grantstown, *E. G. Britton* (*565 p.p.*). Cuba; Porto Rico; Florida.

12. **Rectolejeunea Brittoniae** sp. nov.

Yellowish green, becoming brownish with age, growing in depressed mats: stems about 0.08 mm. in diameter, sparingly and irregularly branched, the branches widely spreading, not microphyllous; rhizoids sparingly produced: leaves imbricated, the lobe plane or slightly convex (when moist), scarcely or not at all falcate, obliquely to widely spreading, broadly ovate to orbicular, averaging about 0.5×0.45 mm., arching partially or wholly across axis, antical margin outwardly curved from the base to the broad and rounded or very obtuse apex, postical margin slightly curved or almost straight, forming an almost continuous line with the keel or with a shallow indentation at the junction, margin slightly and irregularly crenulate from projecting cells, sometimes vaguely sinuate; lobule inflated throughout, triangular-ovate, about 0.1 mm. long and of the same width at the base, keel straight or very slightly arched, free margin curved and involute to or beyond the apex, apical tooth straight and slightly projecting, hyaline papilla in a distinct depression, sinus straight or nearly so, very short (two or three cells long); cells of lobe a little convex, averaging about 17μ at the margin, 25μ in the middle, and 30×25μ at the base, walls with indistinct triangular trigones and rarely with oval intermediate thickenings; ocelli none: underleaves distant to contiguous, orbicular, about 0.35 mm. long, bifid about one half, the divisions mostly acute but sometimes obtuse or even rounded, subcordate or rounded at the base, margin crenulate from projecting cells, sometimes indistinctly unidentate on the sides or vaguely sinuate: inflorescence dioicous: ♀ inflorescence sometimes borne on a short branch but usually on a leading branch, innovating on one side, rarely on both, the innovations often soon floriferous but sometimes sterile; bracts widely spreading, complicate, unequally bifid, keel sharp, sometimes very narrowly winged, lobe ovate to obovate, sometimes slightly falcate, maximum size about 0.6×0.4 mm., apex and margin as in the leaves, lobule narrowly ovate to ligulate, about 0.45×0.15 mm., the apex more or less pointed or bidentate; bracteole oblong, 0.5 mm. long, 0.4 mm. wide, tapering somewhat toward base and apex, bifid about one fourth with acute lobes and sinus, margin as in the underleaves; perianth about one third exserted, oblong to obovate, about 0.65 mm. long and 0.45 mm. wide, rounded to truncate at the apex with a short but distinct beak sometimes borne in a slight depression, slightly compressed in the upper part, antical surface plane or with

a low keel, lateral keels sharp, postical keel two-angled, surface smooth or very slightly roughened from projecting cells: ♂ inflorescence terminal on a leading branch or on a short branch, sometimes occupying the entire length of a short branch, often proliferating; bracts mostly in two to six pairs, imbricated, inflated, subequally bifid with a strongly arched keel and rounded divisions; bracteoles extending the whole length of the inflorescence, similar to the underleaves but smaller and usually with more irregular margins; antheridia in pairs: capsule about 0.3 mm. in diameter; spores minutely verruculose, about 12 μ in short diameter; elaters about 7 μ wide. (PLATE 9, FIGURES 1–12.)

On bark. Great Bahama: edge of mangrove swamp, *Britton & Millspaugh* (*2717*). New Providence: Mt. Vernon, *Coker* (*4*); Soldiers Road, *Coker* (*1 p.p.*, *15 p.p.*), *E. G. Britton* (*692*, *817*, *821 p.p.*, *823 p.p.*, *3166*); Waterloo, *E. G. Britton* (*6598*, *6629 p.p.*, *6641*); Maidenhead Coppice, *E. G. Britton* (*210*, *3215 p.p.*, *3255 p.p.*, *3257 p.p.*, *6563*, *6564*, *6576 p.p.*); vicinity of Lake Cunningham, *N. L. Britton* (*110*), *E. G. Britton* (*609*, *610 p.p.*); near Tea House, *E. G. Britton* (*3193 p.p.*); Cleveland, *Mary Brace* (*4*); Grantstown; *E. G. Britton* (*569*); trail west to Southwest Landing, *E. G. Britton* (*468*); near Clifton, *E. G. Britton* (*739 p.p.*); Fox Hills Path, *Britton & Millspaugh* (*2091*). No. 692 may be designated the type. The species is included under *Cheilolejeunea phyllobola* in Coker's list.

In the various species of *Rectolejeunea* vegetative reproduction is accomplished by means of leaves which break away from the stems and branches and attach themselves to the substratum by scattered rhizoids. The latter grow out directly from marginal leaf cells and sometimes make their appearance before the leaves become separated. The deciduous leaves give rise to new leafy shoots by a process of regeneration. In most cases a leaf will bear but a single leafy shoot, although two or even three are occasionally developed. Apparently a shoot always arises from a marginal leaf cell.

In *R. flagelliformis* Evans,* of Cuba and Porto Rico, and also in *R. Berteroana* the deciduous leaves are strikingly modified and are borne on peculiar flagelliform branches with short internodes and limited growth. These branches spread at

* Bull. Torrey Club 33: 9. *pl. 1. f. 10–25.* 1906.

right angles to the substratum and give a very strange appearance to tufts where they occur abundantly. In *R. phyllobola* the deciduous leaves are less modified, and the shoots upon which they are borne develop internodes of the usual length and continue their growth for a longer period. Even here, however, the shoots acquire a characteristic appearance when a long series of leaves has fallen away leaving the underleaves behind. In *R. Brittoniae* the conditions are much the same as in *R. phyllobola*, the internodes being so long that the underleaves do not overlap. The modifications shown by the deciduous leaves, although slight, are not without interest. The lobes are smaller than on ordinary leaves, and the lobules are so reduced in size that they consist of only a few cells. The postical margins of the lobes are distinctly rounded at the base and form acute angles with the axis. The marginal crenulations are usually better marked than on normal leaves, but this difference is not always apparent. The separation takes place very close to the line of attachment, the basal cells being usually torn across. In all cases the rudimentary lobules are left behind. The leafy shoots which arise from the deciduous leaves, at first bear small and simple leaves, as in other members of the genus, but these soon increase in size and complexity with the further development of the shoot. The underleaves, as a rule, make their appearance very early. The tendency to develop shoots with deciduous leaves is much less marked in *R. Brittoniae* than in its allies, the majority of the plants forming normal shoots only.

The relationship between *R. Brittoniae* and *R. phyllobola* is very close, the leaves, underleaves, and perianths being much alike in the two species. Even the leaf cells agree closely in structure and are very nearly equal in size. There are, however, two important differences: in *R. phyllobola* the inflorescence is autoicous, and the bracteoles of the antheridial spikes are restricted to the base, except of course when only one or two pairs of bracts are present; in *R. Brittoniae*, on the other hand, the inflorescence is dioicous, and the bracteoles are found along the whole length of the antheridial spikes. The species is also a little more robust than *R. phyllobola*, and the underleaves are larger and have broader and usually blunter divisions; in *R. phyllobola*, for example, the divi-

sions are often tipped with two superimposed cells, a condition which is exceedingly rare in *R. Brittoniae.* Unfortunately, in sterile material, the various parts tend to be poorly or abnormally developed, so that it is sometimes difficult to make a positive determination.

13. RECTOLEJEUNEA PHYLLOBOLA (Nees & Mont.) Evans, Bull. Torrey Club 33: 15. 1906.

Cheilolejeunea phyllobola Schiffn. Evans, Mem. Torrey Club 8: 143. *pl. 20. f. 1–13.* 1902.

On bark and rocks. Great Bahama: West End, *Brace* (*3607*). Berry Islands: Lignum Vitae Cay, *Britton & Millspaugh* (*2323*). Andros: road to Morgan's Bluff, *Brace* (*6684*). New Providence: Soldiers Road, *Coker* (*6*); Carmichael, *E. G. Britton* (*442*). Eleuthera: caves near the Bluff, *E. G. Britton* (*6518*). Cat Island: Port Howe and vicinity, *Britton & Millspaugh* (*5972*). Watlings Island: Cockburn Town and vicinity, *Britton & Millspaugh* (*6125, 6134 p.p.*). Tropical North America; Florida; Bermuda.

14. CHEILOLEJEUNEA DECIDUA (Spruce) Evans, Bull. Torrey Club 33: 6. *pl. 1. f. 1–9.* 1906.

On logs. Andros: near Nicholl's Town, *Small & Carter* (*8925a p.p.*). Florida; Porto Rico; Brazil.

15. EUOSMOLEJEUNEA CLAUSA (Nees & Mont.) Evans, Bryologist 11: 69. 1908.

Euosmolejeunea opaca (Gottsche) Steph. Evans, Mem. Torrey Club 8: 139. *pl. 19. f. 1–11.* 1902.

On logs. New Providence: Soldiers Road, *E. G. Britton* (*3170*). Widely distributed in tropical America; Florida and Alabama; Bermuda.

16. EUOSMOLEJEUNEA DURIUSCULA (Nees) Evans, Mem. Torrey Club 8: 135. *pl. 18. f. 12–23.* 1902.

On bark, rarely on rocks. Abaco: Marsh Harbor, *Brace* (*1816*). Andros: near Nicholl's Town, *Small & Carter* (*8966 p.p.*). New Providence: Soldiers Road, *E. G. Britton* (*823 p.p., 165 p.p., 3171*); Maidenhead Coppice, *E. G. Britton* (*256 p.p., 3251, 3252 p.p., 6555a, 6556*); Grantstown, *E. G. Britton* (*558*); coppice near Race Course, *E. G. Britton* (*3419*); north slope of Blue Hills,

E. G. Britton (*584 p.p.*). Widely distributed in tropical America; Florida to Louisiana.

17. EUOSMOLEJEUNEA TRIFARIA (Nees) Schiffn. Evans, Bull. Torrey Club 30: 558. *pl. 22. f. 1–10.* 1903.

On logs. New Providence: Soldiers Road, *E. G. Britton* (*825*); Waterloo, *E. G. Britton* (*6631*). Widely distributed in tropical regions throughout the world.

18. CERATOLEJEUNEA CUBENSIS (Mont.) Schiffn.

On logs. Andros: near Nicholl's Town, *Small & Carter* (*8925a p.p.*). Widely distributed in tropical America; Florida.

19. **Ceratolejeunea integrifolia** sp. nov.

Olive green to olive brown, growing in depressed mats: stems 0.06 mm. in diameter, not closely appressed to the substratum, loosely and irregularly pinnate, the branches widely to obliquely spreading, tending to become parallel in old mats, similar to the stem: leaves imbricated, the lobe widely spreading, slightly convex, somewhat falcate, ovate, 0.35 mm. long, 0.3 mm. wide, arching partially or wholly across axis, antical margin strongly outwardly curved to the apex, postical margin straight or slightly curved, forming an obtuse angle with the keel, apex broad, rounded to very obtuse, margin entire or vaguely and irregularly sinuate; lobule conforming to the type normal for the genus,* though sometimes poorly developed, inflated throughout, ovate, 0.1 mm. long, 0.08 mm. wide, keel arched, very slightly roughened from projecting cells, free margin straight or slightly curved when explanate, involute to apex and arched in natural position, apical tooth short and curved, tapering to a blunt point, hyaline papilla in a slight depression, sinus lunulate; cells of lobe plane or a little convex, averaging about 9μ at the margin, 15μ in the middle, and 18 $\times$ 15μ at the base, walls apparently uniformly thickened, the pits very indistinct; ocelli mostly two (rarely three to five), situated side by side near base of lobe, measuring about 35 $\times$ 16μ: underleaves distant, orbicular, mostly from 0.18 to 0.25 mm. long, broadly cuneate to rounded at the base, bifid about one half with suberect triangular divisions, acute (rarely obtuse) at the apex, and an acute sinus, margin entire or nearly so, rarely with vague indications of rounded lateral teeth: inflorescence dioicous: ♀ inflorescence sometimes borne on a leading branch, sometimes on a more or less abbreviated branch (the latter in extreme cases bearing only one leaf in addition to the bracts), innovating on one

*See Evans, Bull. Torrey Club 32: 275. 1905.

side, the innovation usually simple and sterile; bracts obliquely spreading, complicate with a sharp keel, deeply and unequally bifid, the lobe ovate, mostly 0.45 – 0.6 mm. long and 0.3–0.35 mm. wide but sometimes considerably smaller, rounded to acute at the apex, entire or with an occasional tooth, lobule ovate, mostly 0.35–0.45 mm. long and 0.18–0.2 mm. wide, usually coarsely and irregularly one- to three-cleft in the apical region; bracteole slightly connate on one side, ovate, reaching a maximum size of about 0.5 × 0.25 mm., bifid about one half with suberect acute divisions often reflexed at the apex and a narrow sinus, margin entire or very sparingly and irregularly dentate (rarely with more than one tooth on a side): ♂ inflorescence occupying a short branch or terminal on a more or less elongated branch, often proliferating at the apex; bracts mostly in two or three pairs, rarely in four or five, loosely imbricated, strongly inflated with an arched keel roughened from convex cells, unequally to subequally bifid with blunt divisions; bracteole usually single, at base of inflorescence, similar to the underleaves but smaller: perianth and sporophyte not seen. (PLATE 9, FIGURES 13–19.)

On bark. New Providence: Soldiers Road, *E. G. Britton* (*819 p.p.*, *822*); Waterloo, *E. G. Britton* (*721*); Maidenhead Coppice, *E. G. Britton* (*3220*). Specimens from Florida, collected by Rapp near Sanford, on April 12, 1903, and later, should be referred to this same species. No. 721 may be designated the type.

The specimens above described, although destitute of perianths, are so abundant that they give a fairly good idea of the extent to which the species varies. The characters to be emphasized are the following: the dioicous inflorescence, the basal ocelli, the absence of teeth on the leaves, the usually rounded lobes, the small leaf cells with their walls apparently uniformly thickened, the lack of modified lobules (utriculi, etc.), the small underleaves not cordate at the base, the rarity of teeth on the lobes of the perichaetial bracts and on the bracteoles. The leaf cells bear some resemblance to those of the peculiar West Indian *C. patentissima* (Hampe & Gottsche) Evans,* the pits being equally minute and difficult to demonstrate; the cell cavities, however, are sometimes a little more wavy. The variability in the perichaetial bracts deserves a few words of comment. As the figures show, the bract subtended by the innovation is usually distinctly smaller than the

*Bull. Torrey Club **32**: 287. *pl. 20. f. 19–26.* 1905.

other and the lobe is more sharply pointed. In most cases the lobe shows no teeth whatever, but occasionally one or more angular teeth can be distinguished. The condition described for the lobule may be considered typical, but the number of teeth present in the apical region varies considerably and they are not always sharp. In rare cases the apex of the lobule is merely truncate or retuse with blunt angles. When several teeth are present the apical tooth usually projects beyond the others, and the hyaline papilla may be discerned at the bottom of the sinus on its proximal side. The bracteoles vary in much the same way as the lobes, the divisions being usually entire but sometimes variously dentate. On account of the frequency with which the apices of the divisions are inflexed, it is often difficult to observe the peculiarities of the bracteole clearly without dissection.

Among the species allied to *C. integrifolia* it will be sufficient to mention *C. cubensis*. In this plant the lobules, underleaves, bracts, and bracteoles are much the same as in the new species except that the lobes of the bracts and the divisions of the bracteoles tend to be more regularly toothed. The leaf cells, also, are very similar and there are no differences in the ocelli; the cells, however, sometimes show distinct trigones and intermediate thickenings. The autoicous inflorescence of *C. cubensis* and the dentate leaf lobes will at once serve to distinguish it. The teeth are situated in the apical region of the lobes and usually vary from two to five; they tend to be more conspicuous on branch leaves and are occasionally indistinct on robust stem leaves.

20. **Taxilejeunea obtusangula** (Spruce) comb. nov.

Lejeunea (*Taxi-Lejeunea*) *obtusangula* Spruce, Hep. Amaz. et And. 221. 1884.

Pale green, growing among other hepatics or forming loose depressed mats: stems 0.12 mm. in diameter, loosely and irregularly pinnate, the branches widely spreading, usually with smaller leaves than the stem, at least in basal portions: leaves loosely to closely imbricated, the lobe obliquely spreading, more or less convex, not falcate, orbicular-ovate to ovate, 0.6 mm. long and 0.5 mm. wide on robust sterile axes, arching partially across to considerably beyond the axis, antical margin more or less strongly curved from base to apex, postical margin slightly curved, forming a continuous line or a very obtuse angle with the keel, apex broad

and very obtuse or, more commonly, abruptly apiculate, margin minutely crenulate from projecting cells and sometimes vaguely angular-sinuate or angular-dentate in outer part; lobule inflated throughout, ovate, 0.12 mm. long, 0.08 mm. wide, keel more or less arched, slightly roughened from convex cells, free margin straight or a little curved, involute to or beyond the apex, the latter (not clearly seen without dissection) consisting of a single straight and slightly projecting cell bearing a hyaline papilla at its proximal base, sinus shallow, two or three cells long; cells of lobe slightly convex on both free surfaces, averaging 16 μ at the margin and 32×18 μ in median and basal regions, thin-walled but with distinct triangular trigones and occasional elliptical intermediate thickenings: underleaves distant to contiguous, plane, orbicular to broadly orbicular, measuring 0.3×0.35 mm. on robust axes but often much smaller, cuneate at the base on slender branches but typically rounded to cordate, bifid one third to one half with erect triangular divisions, mostly acute at the apex and tipped with a single cell, rarely rounded, obtuse or apiculate, sinus acute, margin entire or slightly crenulate, rarely vaguely sinuate; inflorescence autoicous: ♀ inflorescence sometimes borne on a leading branch, sometimes on a more or less abbreviated branch (the latter in extreme cases bearing only one leaf in addition to the bracts), innovating on one side, rarely on both, the innovation sometimes simple but usually branched and often again floriferous; bracts obliquely spreading, more or less complicate with a blunt keel, lobe narrower than in the leaves, oblong to oblong-lanceolate, 0.6 mm. long, 0.25 mm. wide, narrowed to the acute or obtuse apex, margin slightly crenulate and irregularly sinuate or sinuate-dentate, lobule very variable, averaging about 0.15×0.08 mm., usually ligulate in outline, the apex blunt or sharp and the margin entire or nearly so; bracteole broadly oblong to oblong-quadrate, averaging about 0.5×0.35 mm., bifid about one third with erect or connivent acute divisions and a very narrow sinus, margin minutely crenulate and often irregularly sinuate-dentate, occasionally with one or two sharp lateral teeth; perianth obovoid from a narrow base, 0.65 mm. long, 0.4 mm. wide, often developing a long cylindrical stipe after fertilization, truncate at the apex with rounded angles, terete below, bluntly five-keeled in apical region, beak none, surface more or less roughened from convex cells especially along the keels: ♂ inflorescence occupying a short branch, not proliferating; bracts in two to six pairs, imbricated, delicate in texture (the cells without local thickenings), shortly and subequally bifid with a strongly arched keel and obtuse to subacute divisions; bracteoles restricted to base of inflorescence, minute, orbicular, similar to the underleaves; antheridia borne

singly: capsule about 0.2 mm. in diameter; spores greenish, minutely verruculose, about 16μ in short diameter; elaters about 9μ wide. (PLATE 10.)

On rocks. New Providence: Maidenhead Coppice, *E. G. Britton* (*256 p.p., 3248, 3249*); without definite locality, *A. E. Wright* (communicated by W. G. Farlow). The species was described by Spruce from specimens which he collected on the trunks of palm trees in the vicinity of Para, Brazil. These specimens were afterwards distributed in Hepaticae Spruceanae. They tend to be a little more robust than the Bahamian plants but agree with them in all essential respects. No other stations for the species are at present known, although its occurrence is surely to be expected in the Antilles and in other intermediate regions.

The great variability of *Taxilejeunea obtusangula* is one of its striking characteristics, and the fact should be emphasized that the perianths are often borne on slender branches which show the typical vegetative peculiarities of the species much less clearly than robust and sterile shoots. The underleaves and the perichaetial bracts are perhaps the most variable organs. Spruce describes the underleaves as imbricated and cordate. The imbrication, however, seems to be exceedingly rare except near the tips of vigorous branches, and although the cordate condition may be considered typical, the majority of the underleaves are rounded or even cuneate at the base. The bracts are especially variable in their lobules, and there is sometimes a marked difference between the outer bract of an inflorescence and the inner bract, especially when the latter is the only one subtended by an innovation. Under these circumstances the lobule of the outer bract is sometimes very slightly modified and may be inflated in much the same way as on ordinary leaves; the lobule of the inner bract, however, is invariably narrow and plane. In other cases the outer bract, even when no innovation subtends it, shows the same modification as the inner bract. Very frequently the lobule is nothing more than a fold at the base of the lobe and can scarcely be distinguished when the bract is spread out flat. The perianth is remarkable because it develops no beak; it simply contracts at the apex to a small circular opening.

The position of *T. obtusangula* in the genus *Taxilejeunea* is

somewhat aberrant, as Spruce has already pointed out. In most of the species which have been referred to this genus the female branch is repeatedly floriferous by innovations and thus gives rise to a sympodial cluster, which bears a series of flowers or perianths along its upper side. In *T. obtusangula* there is no approach to such a condition. The innovation is frequently completely sterile, and even when it is floriferous there is so much space between the two flowers that there is no question of a cluster. The absence of this particular character indicates an approach to the genus *Lejeunea*, but the other characters of the species seem to warrant its retention in *Taxilejeunea*, especially since other species of this genus have been described in which there are no distinct clusters or in which such clusters are only occasionally developed.

21. LEPTOLEJEUNEA ELLIPTICA (Lehm. & Lindenb.) Schiffn. Evans, Bull. Torrey Club **29**: 499. *pl. 23. f. 1–7.* 1902.

On bark. New Providence: Soldiers Road, *E. G. Britton* (*824 p.p.*). Widely distributed in the tropical regions of America, Asia, and the Pacific Islands. Usually growing on living leaves.

22. BRACHIOLEJEUNA BAHAMENSIS Evans, Bull. Torrey Club **35**: 383. *pl. 28. f. 1–14.* 1908.

On bark. Abaco: Old Kerr's Point, *Brace* (*2027 p.p.*). New Providence: Soldiers Road, *Coker* (*1 p.p.*); ten miles west of Nassau, *Coker* (*2*); near Tea House, *E. G. Britton* (*3191*); Grantstown, *E. G. Britton* (*562*); Fox Hills Path, *Britton & Millspaugh* (*2090*); north slope of Blue Hills, *E. G. Britton* (*584 p.p.*). Watlings Island: Cockburn Town and vicinity, *Britton & Millspaugh* (*6120, 6134 p.p.*). Crooked Island: Stopper Hill, *Brace* (*4816*), the type; road to Vauxhall, *Brace* (*4746*). In Coker's list the species appears as *B. corticalis.* Cuba; Florida. The Florida specimens, which have not before been reported, were detected by Miss C. C. Haynes; they were collected by Small and Nash on Old Rhodes Key, south of Miami (*464 p.p.*).

23. BRACHIOLEJEUNEA CORTICALIS (Lehm. & Lindenb.) Schiffn. Evans, Mem. Torrey Club **8**: 131. *pl. 18. f. 1–11.* 1902.

On bark. Great Bahama: Pinder's Point, *Britton & Millspaugh* (*2533*); Barnett's Point, *Britton & Millspaugh* (*2646*);

Golden Grove, *Britton & Millspaugh* (*2719, 2723*). Cat Island: the Bight and vicinity, *Britton & Millspaugh* (*5899*). Tropical America; Florida.

24. LOPHOLEJEUNEA SAGRAEANA (Mont.) Schiffn. Evans, Bull. Torrey Club **34**: 24. *pl. 3. f. 10–20.* 1907.

On bark. Andros: near Nicholl's Town, *Small & Carter* (*8966 p.p.*). New Providence: Soldiers Road, *E. G. Britton* (*818, 824 p.p.*); Waterloo, near old fort, *E. G. Britton* (*2*); Maidenhead Coppice, *E. G. Britton* (*3215 p.p., 3217 p.p., 3250 p.p., 3254 p.p., 3257 p.p., 6554, 6577, 6578*). Widely distributed in tropical America; Florida; also reported from Africa and the East Indies.

25. CAUDALEJEUNEA LEHMANNIANA (Gottsche) Evans, Bull. Torrey Club **34**: 554. *pl. 33. f. 1–12.* 1907.

On twigs. New Providence: Maidenhead Coppice, *E. G. Britton* (*257*). Widely distributed in tropical America; Florida. The Florida specimens have not before been reported; they were collected by Small and Carter near Long Prairie (*2812 p.p.*) and determined by Miss Haynes, who has kindly communicated a portion of the material.

26. MASTIGOLEJEUNEA AURICULATA (Wils. & Hook.) Schiffn. Evans, Mem. Torrey Club **8**: 129. *pl. 17. f. 10–19.* 1902.

On bark and rocks. Andros: near Nicholl's Town, *Small & Carter* (*8967*). New Providence: Mt. Vernon, *Coker* (*7*); Soldiers Road, *E. G. Britton* (*687, 688, 3165, 3169*); Southeast Road, *Coker* (*3*); Waterloo, *E. G. Britton* (*1*); Farringdon Road, *E. G. Britton* (*219, 3260*); Maidenhead Coppice, *E. G. Britton* (*251, 3214, 3250 p.p., 6574*). Widely distributed in tropical America; Florida to Louisiana.

27. ARCHILEJEUNEA VIRIDISSIMA (Lindenb.) Evans, Bull. Torrey Club **35**: 169. *pl. 8. f. 1–8.* 1908.

On bark. Great Bahama: Eight Mile Rocks, *Britton & Millspaugh* (*2605*). Venezuela; Porto Rico; Jamaica.

28. LEUCOLEJEUNEA UNCILOBA (Lindenb.) Evans, Torreya **7**: 228. 1908.

Archilejeunea Sellowiana Steph. Evans, Mem. Torrey Club **8**: 125. *pl. 16. f. 12–20.* 1902.

On bark. New Providence: Soldiers Road, *E. G. Britton* (*666, 3172 p.p.*). Widely distributed in tropical America; Rhode Island south to Florida and west to Texas.

29. LEUCOLEJEUNEA XANTHOCARPA (Lehm. & Lindenb.) Evans, Torreya 7: 229. 1908. Bull. Torrey Club 35: 172. *pl. 7. f. 12–23.* 1908.

On bark. New Providence: Nassau, *A. E. Wight* (communicated by W. G. Farlow); Soldiers Road, *E. G. Britton* (*3168*); Maidenhead Coppice, *E. G. Britton*, *3247 p.p.*). Widely distributed in tropical America; Africa; Java.

30. FRULLANIA ARIETINA Tayl.

On twigs. New Providence: Grantstown, *E. G. Britton* (*557*). Widely distributed in tropical America; Florida.

31. FRULLANIA GIBBOSA Nees.

On bark. Abaco: Old Kerr's Point, *Brace* (*2022*). New Providence; Soldiers Road, *Coker* (*18 p.p.*); Waterloo, *E. G. Britton* (*3 p.p.*); Maidenhead Coppice, *E. G. Britton* (*3247 p.p.*); Lake Cunningham, *E. G. Britton* (*645 p.p.*); near Tea House, *E. G. Britton* (*3194*); near Clifton, *E. G. Britton* (*739 p.p.*). Widely distributed in tropical America: Alabama.*

32. FRULLANIA OBCORDATA Lehm. & Lindenb.
Frullania caroliniana Sulliv.

On bark. New Providence: Soldiers Road, *E. G. Britton* (*820 p.p.*, *3164 p.p.*); Maidenhead Coppice, *E. G. Britton* (*3247 p.p.*); Lake Cunningham, *E. G. Britton* (*645 p.p.*); Grantstown, *E. G. Britton* (*565 p.p.*); Rifle Range Coppice, *E. G. Britton* (*561 p.p.*). Tropical America; Florida to Louisiana.

33. FRULLANIA RIOJANEIRENSIS (Raddi) Spruce.

On twigs. New Providence, *E. G. Britton* (*557*). Widely distributed in tropical America.

34. FRULLANIA SQUARROSA (R. Bl. & N.) Dumort.

On bark. Great Bahama: near Eight Mile Rocks, *Brace* (*3718*). Berry Islands: Lignum Vitae Cay, *Britton & Millspaugh* (*2330*). New Providence: Mt. Vernon, *Coker* (*9*); Soldiers Road, *Coker* (*11*),

* According to Stephani, Species Hepat. 4: 344. 1910. This is the first record for the United States.

E. G. Britton (*823 p.p.*, *3164 p.p.*, *3167*, *3172 p.p.*, *3173*); Waterloo, *E. G. Britton* (*6632*, *6639*); Maidenhead Coppice, *E. G. Britton* (*3217 p.p.*, *6553*, *6575*); Lake Cunningham, *E. G. Britton* (*641*); near Clifton, *E. G. Britton* (*739 p.p.*); Carmichael, *E. G. Britton* (*440*, *443 p.p.*); Seven Hills, *E. G. Britton* (*3361*). Eleuthera: near the Bluff, *E. G. Britton* (*6523*). Anguilla Isles: South End, Salt Key Bank, *Wilson* (*8054*). Widely distributed in tropical regions throughout the world; Connecticut to Ohio and south to Florida and Louisiana; Bermuda.

It will be seen from the species listed that the Jubuleae comprise seven eighths of the entire number and that the Metzgeriaceae are as yet unrepresented in the collections made on the Islands. The Anthocerotaceae are not wholly absent. Sterile specimens of an *Anthoceros* allied to *A. levis* L. were collected by Brace along the Adelaide Road, New Providence (*3917*), but it is impossible to identify them without sporophytes. The preponderance of the Jubuleae indicates the tropical character of the hepatic flora. All but five of the species, in fact, are definitely known from the Antilles and all but ten from Florida, numbers that will doubltess be reduced upon further exploration. Most of the species which occur in the Antilles are confined to the lowlands, even on mountainous islands, although a few of them follow the path of civilization into higher altitudes and make their appearance along roadsides and in plantations. It seems rather surprising at first that only five of the Bahamian species are known from Bermuda.* The flora of the more northern island, however, is much more closely related to that of the northeastern United States, even though it does contain certain subtropical elements.

YALE UNIVERSITY.

* See Evans: The Hepaticae of Bermuda. Bull. Torrey Club **33**: 129–135. *pl. 6.* 1906.

Explanation of plates 9 and 10

The figures were drawn by the writer and prepared for publication by Mr. Stanley C. Ball.

PLATE 9

Rectolejeunea Brittoniae Evans. 1. Part of a branch bearing a perianth with a second female inflorescence on the innovation, postical view, ×35. 2. Part of a leading branch with a male inflorescence, proliferating at the apex, postical view, ×35. 3. Part of a robust sterile branch, postical view, ×35. 4. Leaf, antical view, × 35. 5. Cells from middle of lobe, ×265. 6. Apex of lobe, ×200. 7. Apex of lobule, ×200. 8. Apex of an underleaf division, ×200. 9–11. Bracts and bracteole from a single involucre, ×35. 12. Transverse section of perianth in apical region, ×35. The figures were all drawn from specimens collected by E. G. Britton; FIG. 2, 5, 6, and 7 from *6598*, the others from the type specimen (*692*).

Ceratolejeunea integrifolia Evans. 13. Part of a leading branch with a female inflorescence, postical view, ×35. 14. Part of a leading branch bearing two short branches with female inflorescences, postical view, ×35. 15. Two leaves, antical view, ×35. 16. Cells from middle of lobe, ×265. 17. Apex of lobule, ×200. 18. Apex of an underleaf division, ×200. 19. Bract and bracteole, ×35. The figures were all drawn from the type specimen (*721*).

PLATE 10

Taxilejeunea obtusangula (Spruce) Evans. 1. Part of a leading branch with a perianth and a male inflorescence, postical view, ×35. 2. Short branch with a perianth, postical view, ×35. 3. Part of a robust sterile branch, postical view, ×35. 4. Two leaves, antical view, ×35. 5. Cells from middle of lobe, ×265. 6, 7. Apices of lobes, ×200. 8. Apex of lobule, ×200. 9. Cells from base of underleaf, ×200. 10. Apex of an underleaf division, ×200. 11–13. Bracts and bracteole from a single involucre, ×45. 14–16. Bracts and bracteole from another involucre, × 45. 17. Transverse section of perianth above middle, ×35. The figures were all drawn from specimens collected by E. G. Britton; FIG. 3–10 from *2349*, the others from *256*.

Early spring aspects of the coastal plain vegetation of South Carolina, Georgia, and northeastern Florida

Roland M. Harper

The first week in March, 1910, I journeyed from Washington, D. C., to Jacksonville, Fla., on a through train of the Southern Railway, traversing the Piedmont region from Washington to a few miles north of Columbia, S. C., and the coastal plain the rest of the way. That part of the route lying in the Piedmont region has been in operation, and the region as a whole has been fairly thickly settled, so long that the opportunities for studying natural vegetation from the train along there are now rather limited. But in the coastal plain portion civilization has not yet made such serious inroads. That part of the railroad in South Carolina between Columbia and Perry, 32 miles, and Allendale and Hardeeville, 51 miles, is only about a dozen years old, having been built by the Southern Railway in the last few years of the nineteenth century in order to gain an entrance into Savannah. From Hardeeville to Jacksonville the tracks of the Atlantic Coast Line are used, and of this the part between Jesup and Folkston, Georgia, 54 miles, was built by the Plant System, shortly before its absorption by the Atlantic Coast Line in 1902, to shorten its mileage between Savannah and Jacksonville by about 20 miles. Even along the older parts of the railroads in the coastal plain, such as that between Savannah and Jesup, which has been in operation for half a century, there is still a much larger proportion of the original forest to be seen than in the Piedmont region.

The schedules of the only through train on that route at the time indicated were most convenient for my purposes. Most of the Piedmont region, where what little remains of the vegetation had hardly awakened from its winter sleep (spring having been a little late in the South in 1910), was traversed at night, while in the coastal plain portion of the route, where the vegetation was more advanced, phenologically speaking—mainly on account of the lower latitude and altitude—and there is more for a botanist

to see even in winter, I had daylight all the way. It happens also that I had been over all the Piedmont portion of this route, between Washington and Columbia, by daylight in former years; while south of Columbia it was all new to me except three sections in Georgia, namely, from the Savannah River to Jesup, 74 miles, Hortense to Nahunta, 9 miles, and Folkston to the St. Mary's River, 3 miles. From Columbia to Savannah, however, I was nowhere more than 12 miles from the Seaboard Air Line, on which I had traveled northward a little more than seven months previously.*

The train I was on made about 45 miles an hour, including regular stops (which were few); and at that speed I could not identify many herbs, especially so early in the season. However, some observations of more than passing interest were made on the woody plants, some of which are rapidly becoming scarcer along the route to be described, owing to the "pernicious activity" of lumbermen and farmers.

At daybreak on the fourth of March I was just passing Blythewood, S. C., which is about 20 miles north of Columbia and at the inland edge of the fall-line sandhills, whose summer vegetation I described superficially last year.† These sandhills continued all the way across Richland and Lexington counties, and to the vicinity of Perry in Aiken County, 32 miles south of Columbia. In this region the lumbering of long-leaf pine seems to have practically ceased, and the turpentine industry (which is based on the same tree) nearly so. Agriculture has not quite kept pace with the destruction of the pines, and the region is still very sparsely settled, except in the immediate vicinity of Columbia and other fall-line cities. The highest and barrenest portions of the sandhills, on this route at least, seemed to be about 15 miles south of the Saluda River, or approximately halfway between Columbia and Perry.

The following plants were observed more than once in passing through the sandhill country.‡

*See Bull. Torrey Club 37: 407, 592. 1910–11. My 1910 route crossed that of 1909 at an unnamed point about two-thirds of the way from Columbia to Savannah.

†Bull. Torrey Club 37: 412, 413. 1910.

‡In this and the subsequent lists evergreens are indicated by bold-faced type, which will aid the reader in picturing to himself how they stand out conspicuously

TREES		SHRUBS	
20	**Pinus palustris**	6	**Phoradendron flavescens**
16	Quercus Catesbaei	4	**Smilax laurifolia**
7	Nyssa biflora	3	**Arundinaria tecta**
6	**Pinus Taeda**	3	**Ceratiola ericoides**
5	**Pinus serotina**		
4	**Pinus echinata**		HERBS
2	Liriodendron Tulipifera	4	Kuhnistera pinnata
2	**Magnolia glauca**	3	Andropogon virginicus
2	Acer rubrum	3	**Lupinus diffusus**
2	**Chamaecyparis thyoides**		

The relatively higher rank of most of the evergreens in this list, as compared with the same species in the corresponding list in my previous paper, is of course due mostly to the pre-vernal leaflessness of the deciduous trees. The two non-evergreen herbs mentioned have stiff erect stems which are just about as conspicuous in winter as in summer.

From about Perry to Allendale, 46 miles, I was in the "middle country" or "upper pine belt" (previously described*), which is somewhat less hilly and less sandy than the sandhills, and mostly under cultivation, as I have stated elsewhere. The following plants were noted as characteristic. (The names of introduced species are in parentheses.)

TREES		SHRUBS	
18	**Pinus Taeda**	5	**Phoradendron flavescens**
17	**Pinus palustris**	5	**Smilax laurifolia**
10	Taxodium imbricarium	5	**Arundinaria tecta**
7	Acer rubrum	5	(Prunus angustifolia) †
6	Quercus Catesbaei		
6	Nyssa biflora		HERBS
4	**Magnolia glauca**	4	**Tillandsia usneoides**
3	Quercus marylandica	2	(Isopappus divaricatus)
2	Liquidambar Styraciflua	2	Erianthus sp. (in shallow ponds)
2	(Melia Azederach)		
2	**Quercus nigra**		

The pine barrens may be said to begin with the appearance of

in the winter landscape. The figures here have the same significance as in my 1910 paper above referred to.

*L. c. 411–412.

† This was the only deciduous shrub identified from the train that day. It happened to be in bloom at the time; otherwise I might have not noticed it quite so often.

Pinus Elliottii, near Allendale. The transition from the undulating farming region, just described, to the more typical flat damp pine barrens dotted with shallow ponds is very gradual, however, and the exact boundary cannot be located at present within several miles. A brief description of this kind of country, based on observations made mostly in the same county (Hampton) in 1906 and 1909, has already been published.* Although the railroad between Allendale and Hardeeville is only about a dozen years old, as stated above, the lumbermen have already cut nearly every pine tree within sight of it, that was worth taking. Many of the logs however were doubtless hauled to other railroads near by, or to the Savannah River, before this railroad was built. A pretty good description of the southern part of the region now under consideration can be found in Bulletin 43 of the U. S. Bureau of Forestry, entitled "A working plan for forest lands in Hampton and Beaufort counties, South Carolina," by Thomas H. Sherrard, published in 1903.

The following plants were noted in the 51 miles of pine barrens traversed in South Carolina.

TREES

24 **Pinus Taeda**
22 **Pinus Elliottii**
18 **Pinus palustris**
14 Taxodium imbricarium
10 Nyssa biflora †
10 Acer rubrum
7 **Pinus serotina**
7 **Pinus echinata**
6 **Quercus nigra**
3 **Magnolia glauca**
2 **Magnolia grandiflora**

SHRUBS

9 **Smilax laurifolia**
9 **Ilex glabra**
7 **Myrica cerifera**
6 **Phoradendron flavescens**
5 **Ilex myrtifolia**
2 **Arundinaria tecta**

HERBS

16 **Tillandsia usneoides**
3 Trilisa odoratissima?
3 Carex Walteriana?
2 Erianthus sp. (in ponds)

The occurrence in this list of several woody plants of climax tendencies, such as *Pinus Taeda*, *P. echinata*, *Quercus nigra*, *Magnolia grandiflora*, and *Myrica cerifera*, is probably to be explained by the proximity of the Savannah River bottoms in the

*L. c. 409, 410.

†In Mr. Sherrard's report on this region the black gum is referred, probably erroneously, to *Nyssa sylvatica*. See in this connection Bull. Torrey Club 34: 352. 1907 (fifth footnote).

last few miles. *Quercus Catesbaei* was not seen at all between Allendale and Savannah, probably because the country is not quite high and dry enough for it. It is interesting to note that this list contains five of the six pines which are indigenous to the coastal plain of the Carolinas and Georgia; and the other one, *P. glabra*, was seen in the same region too, but only once. *Pinus palustris* was doubtless originally far more abundant than any other tree in this region.

A mile or so southwest of Hardeeville the railroad enters the bottoms and swamps of the Savannah River, which are here about three miles wide on the South Carolina side and perhaps a little narrower on the Georgia side. Some notes on the swamp timber northwest of Hardeeville (nearer to Purysburg, a place mentioned a few times in Elliott's Botany of South Carolina and Georgia) can be found in the paper by Sherrard, above mentioned.

The following plants were noted more than once in the first seven or eight miles after leaving Hardeeville.

TREES

6 Acer rubrum
5 **Pinus Taeda**
4 Taxodium distichum
4 Nyssa uniflora
4 Liquidambar Styraciflua
4 **Quercus nigra**
3 **Pinus echinata**
2 Ulmus sp.
2 **Magnolia grandiflora**
2 Salix nigra?

SHRUBS

4 **Sabal glabra**
3 **Phoradendron flavescens**
3 **Arundinaria macrosperma**
2 **Myrica cerifera**

HERBS

8 **Tillandsia usneoides**
7 Zizania aquatica

From the river to Savannah and thence southwestward to within a mile and a half of Walthourville, a total distance of about 53 miles, the railroad is mostly in what might be called the coast region of Georgia, though farther inland than the salt marshes and live oak hammocks, which are characteristic of the region. Along the railroad the country is very level, the soil is rather silty, or perhaps marly in a few places, and the vegetation is much nearer the climax condition than it is in the pine barrens a little farther inland. A few estuaries which were crossed bring to view a number of marsh plants, only a few of which were seen more than once, however.

A large part of the coast region has been under cultivation ever since the colony of Georgia was founded, about 175 years ago, and most of the inhabitants are negroes, as is the case in many other parts of the South where agriculture has long been the leading industry. This region corresponds in part to the "savannas" and "live oak bottoms" described by Dr. R. H. Loughridge in his report on the cotton production of Georgia.*

The coastward edge of the pine barrens is rather vaguely defined, and probably irregular as well, and in these 53 miles quite a number of pine-barren plants were seen, which probably indicate tongues or projections of the pine-barren region extending a short distance across the railroad.

It happens that on July 17, 1909, I came into Savannah from the southwest, the last 57 miles being on the same route here described, and then turned westward, passing out of the coast region near Meldrim, about 18 miles from Savannah. In order to compare the summer and winter aspects of the vegetation along what is for the most part the same route, I will here place in parallel columns the results of the two trips, the first from Walthourville to Savannah and Meldrim, 56 miles, and the second from the Savannah River to Savannah and near Walthourville, 53 miles.

July	*March*
TREES	TREES
33 **Pinus Taeda**	29 **Pinus Taeda**
24 Liquidambar Styraciflua	20 Acer rubrum
23 Nyssa biflora	15 Nyssa biflora
20 **Pinus serotina**	15 **Pinus serotina**
12 Taxodium imbricarium	12 **Pinus palustris**
11 **Pinus Elliottii**	8 **Pinus Elliottii**
6 **Pinus palustris**	8 **Magnolia glauca**
6 Acer rubrum	7 **Quercus nigra**
4 Taxodium distichum	6 **Magnolia grandiflora**
3 Nyssa uniflora	5 Liquidambar Styraciflua
2 Nyssa Ogeche	4 Taxodium imbricarium

* Tenth Census U. S. **6**: 317, 318, 423, 424. 1884. Also in Henderson's Commonwealth of Georgia, 114–116. 1885. Later descriptions of the same region can be found in Ann. N. Y. Acad. Sci. **17**: 20. 1906; and in the preliminary reports on the soils in the vicinity of Savannah and Brunswick by J. A. Bonsteel and H. H. Bennett, respectively (circulars 19 and 21 of the U. S. Bureau of Soils, July, 1909, and February, 1910).

2 **Pinus echinata**
2 Quercus Phellos

SHRUBS

5 **Serenoa serrulata**
4 **Phoradendron flavescens**
3 **(Baccharis halimifolia)**
3 **Myrica cerifera**
2 Clethra alnifolia

HERBS

23 **Tillandsia usneoides**
8 Eupatorium rotundifolium
6 Eriocaulon decangulare
5 Pluchea bifrons
4 Pontederia cordata
3 Osmunda cinnamomea
3 Scirpus Eriophorum
3 Jussiaea grandiflora
2 Zizania aquatica
2 **Juncus Roemerianus**
etc.

4 Quercus falcata
4 Taxodium distichum
3 Nyssa uniflora
3 **Pinus echinata**
2 **Quercus virginiana**
2 **Juniperus barbadensis?** (on borders of marshes)

SHRUBS

20 **Myrica cerifera**
12 **Phoradendron flavescens**
8 **Sabal glabra**
6 **Serenoa serrulata**
5 **(Baccharis halimifolia)**
4 **Ilex glabra**
2 **Smilax lanceolata**

HERBS

28 **Tillandsia usneoides**
5 **Juncus Roemerianus**
4 Zizania aquatica
3 **Orontium aquaticum**

It will be noticed that the five pines, also *Taxodium distichum*, *Nyssa uniflora*, *Phoradendron*, *Baccharis*, and *Tillandsia*, occupy the same relative rank, or nearly so, in both lists. *Acer rubrum* and *Liquidambar* just about interchange places, doubtless because in March the former was in fruit, and therefore conspicuous and unmistakable, while the latter is not so readily identified when its characteristic leaves are off, especially in young trees which bear no fruit. *Magnolia glauca*, *M. grandiflora*, and *Myrica cerifera*, which stand higher in the March list, are evergreen, and *Quercus nigra* nearly so in that latitude.

From Walthourville to Jesup, Folkston, and Jacksonville, a distance of about 118 miles, my route was through flat pine barrens, averaging perhaps 50 feet above sea level, dotted with numerous very shallow depressions with no outlets, and traversed by sluggish streams, most of them mere branches, with their channels only a few inches or feet below the general level, and bordered by comparatively wide swamps. This region corresponds approximately with Loughridge's "pine and palmetto flats"* in Georgia, and

* Tenth Census U. S. 6: 316, 317, 415, 421. 1884. See also Ann. N. Y. Acad. Sci. 17: 19, 20. 1906; Southern Woodlands 1[3]: 20–23. 1907 (where I treated it as a subdivision of the Altamaha Grit region); and Pop. Sci. Monthly 74: 601, 602. 1909.

with the flatwoods of northeastern Florida, described at the same time by Dr. E. A. Smith.*

In Nassau County, Florida, about 30 miles out from Jacksonville, the railroad crosses obliquely a low sandy ridge which seems to extend parallel to the coast for over 100 miles in Georgia and Florida.† About the only noticeable difference in the country east and west of this ridge is that east of it many of the creeks seem to have cut down through the sand and clay of the pine barrens into marl beds, as indicated by the presence of supposedly calciphile plants like *Taxodium distichum*, *Juniperus*, *Sabal*, *Cladium*, etc., in their swamps.‡

In these flat pine barrens lumbering is a very simple operation, and the lumbermen have already done their worst. Along the route here described the day of the big sawmill§ is past, and small ones and turpentine stills are becoming scarce. The greater part of this destruction of forests was probably accomplished in the decade immediately preceding the building of the short line from Jesup to Folkston. Long-leaf pines are still everywhere in sight, but only small or defective specimens. The farmer is following slowly after the lumberman, and will probably in time obliterate nearly all distinctions between this region and the adjoining ones, except the topography.

Although many plants have been collected in the neighborhood

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*Tenth Census U. S. **6**: 202, 203, 231, 232. 1884. The latest descriptions of this part of Florida are in the Third Annual Report of the Florida State Geological Survey (January, 1911), pages 92, 96, 97, 126, 135, 136, 224, 225.

†For notes on this ridge in geographical literature see Loughridge, Tenth Census U. S. **6**: 315, 316 (last paragraph), 317, 421, 423, 424. 1884; McCallie, Geol. Surv. Ga. Bull. 8: 96 (line 26). 1902; Sellards & Gunter, Ann. Rep. Fla. Geol. Surv. **3**: 126, 136. 1911. Also Pop. Sci. Monthly **74**: 603 (near bottom), 605. 1909; Ann. Rep. Fla. Geol. Surv. **3**: 225. *pl. 16*. 1911. It was called a terrace by Loughridge, and a dune by McCallie.

‡See Bull. Torrey Club **32**: 158, 459. 1905. One of the calcareous swamps between Folkston and Jacksonville, which I first observed from the train on March 4th and examined at leisure the latter part of May, contributed largely to the habitat list on pages 241 and 242 of the Florida report just cited.

§In the long-leaf pine region a pretty sharp distinction can be made between big and little sawmills, the former being built to stay several years, and being provided with a waste burner or slab pit, a contrivance by which the slabs wasted in sawing are conveyed up a long incline and dropped into a fire which burns day and night. The small mills are more temporary affairs, and lack this conspicuous appendage.

of Jesup, Folkston, and especially Jacksonville, the vegetation of the flat pine barrens has apparently never been described except in the most vague and general terms, as it might be by a person with no knowledge of botany whatever. And Nassau County, Florida, through which I passed for 23 miles, has scarcely been visited by collectors or mentioned in botanical literature.

The following list will give the reader a pretty good idea of the prevailing trees and evergreen shrubs of the region under consideration, but of course only a very small fraction of the herbs.

TREES

72 **Pinus Elliottii**
63 **Pinus palustris**
59 Taxodium imbricarium
28 **Pinus serotina**
20 **Magnolia glauca**
19 Acer rubrum
11 Nyssa biflora
8 Quercus Catesbaei
7 **Pinus Taeda**
4 Taxodium distichum
4 **Quercus nigra**
2 **Juniperus virginiana?**
2 **Magnolia grandiflora**

SMALL TREES OR LARGE SHRUBS

21 **Cliftonia monophylla**
21 **Ilex myrtifolia**
5 Nyssa Ogeche

SHRUBS

68 **Serenoa serrulata**
29 **Ilex glabra**
20 **Smilax laurifolia**
5 **Phoradendron flavescens**
4 **Sabal glabra**
2 **Pieris nitida**

HERBS

20 **Tillandsia usneoides**
3 Aristida stricta
2 Andropogon virginicus
2 **Cladium effusum**

Besides the branch, creek, and river swamps common to most flat pine-barren regions there are two other palustrine types of vegetation, characterized by shallow stagnant water; namely, cypress ponds, with *Taxodium imbricarium* and *Pinus Elliottii* the dominant trees, and a lower story of *Ilex myrtifolia* and often *Nyssa biflora;* and bays (somewhat resembling the pocosins of eastern North Carolina), with *Pinus serotina* or sometimes *P. Elliottii* dominant and a dense undergrowth of large evergreen shrubs and vines, such as *Cliftonia* and *Smilax*. *Pinus Elliottii* and *P. serotina*, though sometimes seen together, were usually separated. Just what causes the difference in the vegetation of these two kinds of depressions is not clear, but it seems probable that the sand is deeper and the water level more constant in the bays than in the ponds; and my recent studies of Florida

peat problems have shown that the amount of seasonal fluctuation of water is of fundamental importance to aquatic vegetation, thus explaining several peculiarities of distribution which could not be satisfactorily explained in any other way.

The following notes will throw some light on the inland, coastward, northern or southern limits of certain species observed in the ten hours it took to go from Blythewood to Jacksonville.

NYSSA OGECHE Marsh. Occasional from the Altamaha River to the St. Mary's, including the swamps of both rivers. This species has long been credited to South Carolina, perhaps because it was once described by Walter (as *N. capitata*). But Walter's Flora Caroliniana contains the names of a considerable number of plants that probably do not grow within many miles of his home (which was near the center of the coastal plain of South Carolina), and a few that have not even been seen in South Carolina at all, in modern times at least; and it is reasonable to assume that he had some specimens from the two adjoining states in addition to those from his own.*

The Michauxs, father and son, and Elliott, all placed the northeastern limit of *Nyssa Ogeche* at or near the Ogeechee River in Georgia; and I do not remember seeing it even as far northeast as that, although I have crossed that river on every railroad bridge and a few wagon bridges, making over a dozen different places in all. Herbarium specimens distributed by the late Dr. J. H. Mellichamp of Bluffton, S. C., would appear to be from a tree transplanted from the Ogeechee River swamps, judging from a brief note in Garden and Forest (7: 500) for Dec. 12, 1894.

*Among the species mentioned by Walter, which do not seem to have been seen in his neighborhood recently, if at all, the following occur to me:

Marshallia trinervia, *Mesadenia sulcata* (see Torreya 5: 183), *Aster carolinianus*, *Asclepiodora viridis* (see Ell., Sk. 1: 327. 1817), *Frasera carolinensis*, *Sabbatia decandra* (see Bull. Torrey Club 37: 595), *Cholisma ferruginea*, *Leucothoe Catesbaei*, *Zizia cordata*, *Ilex myrtifolia*, *Robinia hispida*, *Baptisia villosa* (see Coker, Torreya 11: 10), *Crataegus aestivalis*, *Malapoenna geniculata*, *Benzoin melissaefolium*, *Magnolia Fraseri*, *Nymphaea sagittifolia* (see Bull. Torrey Club 37: 598), *Trautvetteria carolinensis*, *Ponthieva racemosa*, *Cypripedium Reginae*, *Iris hexagona*, *Canna flaccida* (see Bull. Torrey Club 32: 156), *Smilax auriculata*, *Sabal Palmetto*, *Pinus glabra*, and a considerable number of strictly maritime plants. (The names used in this paragraph are the modern ones, which are different in most cases from those used by Walter. The specific names are the same as his in all but two or three cases, however.)

In another direction I have not seen this curious little tree even as far southeast as Duval County, Florida, but Mr. W. M. Canby, if there is no error about his label, collected specimens of it in March, 1869, near Hibernia in Clay County, about 20 miles south of Jacksonville.

NYSSA UNIFLORA Wang. Occasional from the Carolina side of the Savannah River swamp to about five miles northeast of Walthourville. In former years I have seen it on the Altamaha River down to within about twenty miles of the coast, but it is not known in eastern Florida at all, or anywhere near Okefinokee Swamp. It seems to grow only in swamps where the water fluctuates not less than three nor more than ten feet during the year.

ILEX MYRTIFOLIA Walt. First noticed just north of Barton, in the lower edge of Barnwell County, South Carolina. Frequent in cypress ponds the rest of the way to Jacksonville, except in the coast region between Hardeeville and Walthourville. Some of our manuals credit this to North Carolina or even to Virginia, but I have never seen it any farther north than the point just mentioned, or anywhere outside of the range of *Pinus Elliottii*.

CLIFTONIA MONOPHYLLA (Lam.) Sarg. Abundant nearly all the way through Wayne County, Georgia, between Doctortown and Nahunta, a distance of about 30 miles; but not seen elsewhere on this trip. It seems to reach its northeastern limit between the Ogeechee and Savannah rivers, where it has been observed in three different centuries, by Bartram,* Michaux,† Nuttall,‡ and myself.

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* Travels, 31. 1791.

† In the Journal of André Michaux, edited by C. S. Sargent, and published in 1889, there is the following interesting entry under date of May 19, 1787, when father and son were journeying together from Savannah to Augusta, mostly following the high ground between the Savannah and Ogeechee rivers:

"Un peu avant d'arriver à Beaver Dam [Creek] je recueillis sur la route, étant alors à 60 milles de distance d'Augusta, un Rumex arbriss. que je nommeray Lapathum occidentale, grand arbriss[eau], de 25 à 30 pieds de haut. Il se trouve aussi près de la rivièrre Altamaha, d'où mon fils me l'avoit apporté les jours précédents."

Prof. Sargent in a footnote here refers this "*Rumex* bush" doubtfully to *Brunnichia cirrhosa;* but the occurrence of *Brunnichia* in such a place (which was probably a few miles east of where Sylvania now is) is highly improbable, and besides, Michaux would hardly have described *Brunnichia* as a shrub. Furthermore, it does not bloom until midsummer, and in May there would have been little to suggest its affinity to *Rumex*. *Cliftonia*, however, has green fruit on it in May, and this re-

I have never found it within about 25 miles of the coast in Georgia; and like *Nyssa uniflora*, but doubtless for different reasons, it is not known to occur in eastern Florida.

CERATIOLA ERICOIDES Michx. Observed three times on the highest and driest sandhills of Lexington County, South Carolina, about halfway between Columbia and Perry, which must be near its northern limit. *Kuhnistera pinnata* and *Lupinus diffusus* were seen with or near it, and nowhere else on that day.

BAPTISIA PERFOLIATA (L.) R. Br. This most striking (and one of the least widely distributed) species of *Baptisia* was seen only once on the day indicated, namely, a little north of Kline, in Barnwell County, South Carolina.

MAGNOLIA GRANDIFLORA L. First noticed in the upper edge of Hampton County, South Carolina. This beautiful tree is evidently much rarer in South Carolina than in some of the states farther west.

MYRICA CERIFERA L. Frequent from a point a little north of Barnwell, S. C., southward.

TILLANDSIA USNEOIDES L. First seen in the swamp of the South Fork of the Edisto River on the boundary between Orangeburg and Barnwell counties, South Carolina, where it is very abundant. This characteristic coastal plain epiphyte seems to reach the fall-line only along or near the muddy rivers,* and the Edisto is not of that class.†

ORONTIUM AQUATICUM L. Seen on this trip only in the estuarine marshes of the Ogeechee River, Georgia. Throughout its

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sembles that of *Rumex* (section *Lapathum*) about as much as anything else. It is also common near the Altamaha River. Michaux's first-named locality must be very near where Bartram saw the same plant in the preceding decade.

The type locality of this species (*Ptelea monophylla* Lam.) was given as "Carolina," but that should not be taken too literally. Strange to say, it does not seem to have been mentioned, under any name, in Michaux's Flora Boreali-Americana or in his son's North American Sylva (it was afterward added to the latter by Nuttall, though); but this is true of several other plants mentioned in Michaux's journal, and probably indicates that their specimens in such cases, if they preserved any, got lost.

‡N. Am. Sylva 2: 93. 1846.

*In this connection see Nuttall's remarks on the distribution of this species, in his Genera 1: 208, 209. 1818.

†See Bull. Torrey Club 34: 257. 1907.

range its favorite habitat seems to be stagnant or gently flowing non-calcareous water whose level does not vary more than a foot or so during the year.

SERENOA SERRULATA (Michx.) B. & H. First seen in Chatham County, Georgia, about six miles beyond where the Savannah River was crossed. It is reported from South Carolina, but in that state is perhaps confined to the southernmost county, Beaufort, in which I have never been.

SABAL PALMETTO (Walt.) R. & S. Seen only in the marshes of the Little Ogeechee River, Chatham County, Georgia. The rest of the way I was evidently too far inland for it.

SABAL GLABRA (Mill.) Sarg. First noticed in the Savannah River bottoms near Hardeeville, S. C.

CLADIUM EFFUSUM (Sw.) Torr. Seen only between Callahan and Jacksonville, Florida, in a few shallow swamps where limestone is assumed to be near the surface. In other states it seems to be almost confined to estuarine marshes near the coast, but in Florida it grows in nearly every county.

TAXODIUM. Both species were first encountered this time in Barnwell County, South Carolina, *T. imbricarium* in the northern edge of the county, and *T. distichum* just south of the county seat. Both extend far down into Florida.*

CHAMAECYPARIS THYOIDES (L.) B.S.P. Noticed twice along creeks in the sandhills of Lexington County, South Carolina, about ten miles southwest of Columbia.

JUNIPERUS. Whether the *Juniperus* which is indigenous near the southern coast is *J. virginiana* or *J. barbadensis*, or both, I have never been able to determine. Trees of this genus were seen in the Little Ogeechee marshes, Chatham County, Georgia, and in two supposedly calcareous swamps between Callahan and Jacksonville, Florida. (I afterwards collected specimens at the locality nearest Jacksonville.) It is decidedly rare in eastern Florida.

PINUS GLABRA Walt. Seen first in the upper edge of Hampton County, South Carolina, and last just north of the Ogeechee River in Georgia. Farther south the boundary of its range seems to diverge considerably from the coast.

*See Ann. Rep. Fla. Geol. Surv. 3: 352, 353. 1911.

PINUS ELLIOTTII Engelm. First seen about a mile north of Allendale, S. C., which is pretty close to the place where I last saw it on my way northward in 1909, which may safely be taken as its northern limit.*

UNIVERSITY, ALA.

*See Bull. Torrey Club 37: 603. 1911.

List of plants collected above timber line on Pikes Peak, with altitudinal extensions and notes

Blanche Soth

Experts might be able to differentiate a few other varieties and species of grasses and sedges in addition to the conspicuous ones given in the following list of plants collected above the timber line on Pikes Peak; otherwise this list is exhaustive and my determinations have been corrected and verified by the submission of doubtful specimens to Dr. P. A. Rydberg and Dr. Aven Nelson, both of whom have been most kind in this respect as well as in giving me information upon doubtful points. They have my sincere thanks for their interest and assistance.

1. Achillea lanulosa Nutt.
2. Aconitum columbianum Nutt.
3. Adoxa moschatalina L.
4. Agoseris aurantiaca (Hook.) Greene
   (*Troximon aurantiacum* Hook.)
5. Agropyrum Scribneri Vasey
6. Allium pikeanum Rydb.
7. Alsinopsis obtusiloba Rydb.
   (*Arenaria sajanensis* Willd.)
8. Alsinopsis propinqua Rydb.
9. Androsace carinata Torr.
10. Androsace subumbellata (A. Nels.) Small
11. Angelica Grayi C. & R.
12. Antennaria aprica Greene
13. Antennaria media Greene
14. Antennaria microphylla Rydb.
15. Antennaria nardina Greene
16. Antennaria rosea (Eat.) Greene
17. Aquilegia coerulea James
18. Aquilegia saximontana Rydb.
19. Arabis Drummondii A. Gray
20. Arenaria Fendleri A. Gray
21. Artemisia Pattersonii A. Gray
22. Artemisia scopulorum A. Gray
23. Bistorta bistortoides (Pursh) Small
24. Bistorta vivipara (L.) S. F. Gray
25. *Boykinia Jamesii* (Torr.) Engler [Telesonix Jamesii (Torr.) Raf.]
26. Calamagrostis purpurascens R. Br.
27. Caltha leptosepala Hook.
28. Campanula rotundifolia L.
29. Campanula uniflora L.
30. Carduus scopulorum Greene
31. Carex alpina Sw.
32. Carex capillaris L.
33. Carex chalciolepis Holm
34. Carex ebenea Rydb.
35. Carex festiva Dewey
36. Carex melanocephala Turcz.
37. Carex petasata Dewey
38. Carex rupestris All.
39. Carex scopulorum Holm
40. Castilleja lancifolia Rydb.
41. Castilleja occidentalis Torr.
42. Castilleja sulphurea Rydb.
43. Cerastium beeringianum C. & S.
44. Cerastium oreophilum Greene
45. Chamaenerion angustifolium (L.) Scop.
46. Chionophila Jamesii Benth.
47. Chondrophylla americana (Engelm.) A. Nels.
48. Claytonia megarrhiza (A. Gray) Parry
49. Clementsia rhodantha (A. Gray) Rose
50. Conioselinum scopulorum (A. Gray) C. & R.
51. Dasiphora fruticosa (L.) Rydb.
52. *Deschampsia caespitosa alpina* Vasey [D. alpicola Rydb.]
53. Dodecatheon pauciflorum (Durand) Greene

54. DRABA AUREA Wahl.
55. DRABA PARRYI Rydb.
56. DRABA STREPTOCARPA A. Gray
57. DRYAS OCTOPETALA L.

58. ELEPHANTELLA GROENLANDICA (Retz.) Rydb.
59. EPILOBIUM ANAGALLIDIFOLIUM Lam.
60. EPILOBIUM OVATIFOLIUM Rydb.
61. EPILOBIUM STRAMINEUM Rydb.
62. ERIGERON ELATIOR (A. Gray) Greene
63. ERIGERON FORMOSISSIMUS Greene
64. ERIGERON PINNATISECTUS (A. Gray) A. Nels.
65. ERIGERON SIMPLEX Greene
66. ERIGERON SMITHII Rydb.
67. ERITRICHIUM ARGENTEUM Wight
68. ERYSIMUM OBLANCEOLATUM Rydb.

69. FESTUCA BRACHYPHYLLA Schultes
70. FESTUCA OVINA INGRATA Hackel
71. FRAGARIA GLAUCA Wats.
72. FILIX FRAGILIS (L.) Und.

73. *Gentiana Parryi* Engelm. [DASYSTEPHANA PARRYI (Engelm.) Rydb.]
74. *Gentiana plebeja* Cham. [AMARELLA PLEBEJA (Cham.) Greene]
75. *Gentiana Romanzovii* Ledeb. [DASYSTEPHANA ROMANZOVII (Ledeb.) Rydb.]

76. HEUCHERA HALLII A. Gray
77. HEUCHERA PARVIFOLIA Nutt.

78. JUNCOIDES PARVIFLORUM (Ehrh.) Coville [*Luzula parviflora* (Ehrh.) Desv.]
79. JUNCOIDES SPICATUM (L.) Kuntze [*Luzula spicata* (L.) D. C.]
80. JUNCUS CASTANEUS Smith
81. JUNCUS DRUMMONDII Mey.
82. JUNCUS TRIGLUMIS L.

83. *Lewisia pygmaea* (A. Gray) Robins. [OREOBROMA PYGMAEA (A. Gray) Howell]
84. LLOYDIA SEROTINA (L.) Sweet
85. LYCHNIS MONTANA Wats.

86. MACHAERANTHERA ASPERA Greene
87. MERTENSIA ALPINA (Torr.) Don
88. MERTENSIA CILIATA (Torr.) Don

89. OREOCHRYSUM PARRYI (A. Gray) Rydb.
90. OREOXIS HUMILIS Raf.
91. OXYRIA DIGYNA (L.) Compt.
92. PARONYCHIA PULVINATA A. Gray
93. PEDICULARIS PARRYI A. Gray
94. PENTSTEMON HALLII A. Gray
95. PENTSTEMON GLAUCUS STENOSEPALUS A. Gray
96. PHACELIA SERICEA Hook.
97. PHLEUM ALPINUM L.
98. POA ARCTICA R. Br.
99. POA GRAYANA Vasey
100. POA PHOENICEA Rydb.
101. POA RUPICOLA Nash
102. POLEMONIUM CONFERTUM A. Gray
103. POLEMONIUM PULCHERRIMUM Hook.
104. POTENTILLA BIPINNATIFIDA Dougl.
105. POTENTILLA FILIPES Rydb.
106. POTENTILLA GLAUCOPHYLLA Lehm.
107. POTENTILLA VIRIDIOR Rydb.
108. POTENTILLA SAXIMONTANA Rydb.
109. PRIMULA ANGUSTIFOLIA Torr.
110. PRIMULA PARRYI A. Gray
111. PSEUDOCYMOPTERUS MULTIFIDUS Rydb.
112. PSEUDOCYMOPTERUS PURPUREUS (C. & R.) Rydb.

113. RANUNCULUS INAMOENUS Greene
114. RHODIOLA INTEGRIFOLIA Raf.
115. RHODIOLA POLYGAMA (Rydb.) B. & R.
116. RIBES LENTUM (Jones) C. & R.
117. RORIPA ALPINA (S. Wats.) Rydb.
118. RUBUS STRIGOSUS Michx.
119. RYDBERGIA GRANDIFLORA (Pursh) Greene

120. SALIX BRACHYCARPA Nutt.
121. SALIX SAXIMONTANA Rydb.
122. *Saxifraga austromontana* Wieg. [LEPTASEA AUSTROMONTANA (Wieg.) Small]
123. SAXIFRAGA CERNUA L.
124. *Saxifraga chrysantha* A. Gray [LEPTASEA CHRYSANTHA (A. Gray) Small]
125. SAXIFRAGA DEBILIS Engelm.
126. *Saxifraga flagellaris* Willd. [LEPTASEA FLAGELLARIS (Willd.) Small]
127. *Saxifraga rhomboidea* Greene [MICRANTHES RHOMBOIDEA (Greene) Small]
128. SEDUM STENOPETALUM Pursh
129. SENECIO ATRATUS Greene
130. SENECIO CARTHAMOIDES Greene
131. SENECIO CHLORANTHUS Greene
132. SENECIO CROCATUS Rydb.
133. SENECIO EREMOPHILUS A. Gray
134. SENECIO FENDLERI A. Gray
135. SENECIO PUDICUS Greene
136. SENECIO TARAXICOIDES A. Gray
137. SENECIO WERNERIAEFOLIUS A. Gray
138. SELAGINELLA DENSA Rydb.

139. SIBBALDIA PROCUMBENS L.
140. SIEVERSIA TURBINATA (Rydb.) Greene
141. SILENE ACAULIS L.
142. SOLIDAGO DECUMBENS Greene
143. SOPHIA INCISA (Engelm.) Greene
144. *Stellaria crassifolia* Ehrh. [ALSINE CRASSIFOLIA (Ehrh.) Britton]
145. *Stellaria umbellata* Turcz. [ALSINE BAICALENSIS Coville]
146. SWERTIA PALUSTRIS A. Nels.
147. *Synthyris alpina* A. Gray [BESSEYA ALPINA (A. Gray) Rydb.]
148. TARAXACUM DUMETORUM Greene
149. TETRANEURIS LANATA (Nutt.) Greene [*Actinella lanata* Nutt.]
150. THALICTRUM ALPINUM L.
151. THLASPI COLORADENSE Rydb.
152. TONESTUS PYGMAEUS (T. & G.) A. Nels.
153. TRIFOLIUM DASYPHYLLUM T. & G.
154. TRIFOLIUM NANUM Torr.
155. TRISETUM SUBSPICATUM (L.) Beauv.
156. VERONICA ALPINA L.
157. *Zygadenus elegans* Pursh [ANTICLEA ELEGANS (Pursh) Rydb.]

ALTITUDINAL EXTENSIONS

The first column gives the upper limit of altitude according to the Flora of Colorado, the second, the highest altitude at which I found the species on Pikes Peak.

ACHILLEA LANULOSA Nutt.	12,000	12,600
ANTENNARIA MICROPHYLLA Rydb.	11,000	12,000
ANTENNARIA ROSEA (Eat.) Greene	11,000	12,000
ARABIS DRUMMONDII A. Gray	11,500	12,000
BISTORTA BISTORTOIDES (Pursh) Small	13,000	13,500
BISTORTA VIVIPARA (L.) S. F. Gray	12,000	13,000
CALTHA LEPTOSEPALA Hook.	12,000	13,000
CAMPANULA UNIFLORA L.	——	13,000
CASTILLEJA SULPHUREA Rydb.	10,000	12,000
CARDUUS SCOPULORUM Greene	12,000	13,000
CHAMAENERION ANGUSTIFOLIUM (L.) Scop.	10,000	12,600
CHONDROPHYLLA AMERICANA (Engelm.) A. Nels.	12,000	13,000
CONIOSELINUM SCOPULORUM (A. Gray) C. & R.	11,000	12,000
DASIPHORA FRUTICOSA (L.) Rydb.	10,000	12,500
DODECATHEON PAUCIFLORUM (Durand) Greene	8,500	12,000
ELEPHANTELLA GROENLANDICA (Retz.) Rydb.	12,000	13,000
EPILOBIUM STRAMINEUM Rydb.	11,000	12,000
ERIGERON FORMOSISSIMUS Greene	——	12,000
ERIGERON SIMPLEX Greene	——	13,500
ERIGERON SMITHII Rydb.	10,000	12,000
ERYSIMUM OBLANCEOLATUM Rydb.	11,000	12,000
FRAGARIA GLAUCA Wats.	11,000	12,000
Gentiana plebeja Cham. [AMARELLA PLEBEJA (Cham.) Greene]	10,000	12,500
Lewisia pygmaea (A. Gray) Robins. [OREOBROMA PYGMAEA (A. Gray) Howell]	12,000	13,000
LYCHNIS MONTANA Wats.	——	12,000
MACHAERANTHERA ASPERA Greene	10,000	12,000
OREOXIS HUMILIS Raf.	13,000	14,000
PENTSTEMON GLAUCUS STENOSEPALUS A. Gray	12,000	13,000
POTENTILLA BIPINNATIFIDA Dougl.	10,000	12,000
POTENTILLA FILIPES Rydb.	10,000	12,000
POTENTILLA VIRIDIOR Rydb.	——	12,000
PSEUDOCYMOPTERUS MULTIFIDUS Rydb.	10,000	12,000
PSEUDOCYMOPTERUS PURPUREUS (C. & R.) Rydb.	11,500	12,500
RANUNCULUS INAMOENUS Greene	10,000	12,000
RORIPA ALPINA (S. Wats.) Rydb.	——	11,500

RUBUS STRIGOSUS Michx.	10,000	12,000
SALIX BRACHYCARPA Nutt.	11,000	13,000
Saxifraga rhomboidea Greene	12,000	13,000
[MICRANTHES RHOMBOIDEA (Greene) Small]		
SELAGINELLA DENSA Rydb.	7,000	12,500
SENECIO CHLORANTHUS Greene	11,000	12,000
SENECIO EREMOPHILUS A. Gray	10,000	12,000
SENECIO WERNERIAEFOLIUS A. Gray	——	11,500
SOPHIA INCISA (Engelm.) Greene	9,000	11,500
Stellaria crassifolia Ehrh.	10,000	12,000
[ALSINE CRASSIFOLIA (Ehrh.) Britton]		
TARAXACUM DUMETORUM Greene	10,000	12,000
THALICTRUM ALPINUM L.	12,000	13,000
VERONICA ALPINA L.	12,000	13,000

NOTES

The timber line on Pikes Peak occurs at an altitude of approximately 11,500 feet. While the trees extend a little higher in a few places, only those plants which were actually growing above the protection of the timber were included in this list. I collected some species which have not been thought to enter the Arctic-Alpine Zone. Some of these undoubtedly belong there while a few have spread upward from the timber line owing to favorable local environments. In general, I find two localities in which the latter plants are to be found; one is the slope on which is located the pumping station at Windy Point, and the other is the glacial amphitheater which is partly occupied by Reservoir No. 7 of the Colorado Springs water system. Both these slopes are well watered throughout the growing season and are of southerly exposure, while huge boulders and outcropping ledges give ample protection from the drying and chilling winds that sweep the more exposed portions of the peak, and also serve as obstacles to the removal of the finer and richer soil, the products of both rock and vegetable decay.

A third area of upward extension is the boggy ground along the carriage road west of the peak, where I found some hydrophilous plants at 13,000 feet, which heretofore were not supposed to grow much above the timber line.

I found no edible vegetation of any consequence. *Fragaria glauca* ripened a few small, imperfect berries on a sunny bank just above the timber, while the leaves of *Caltha leptosepala* might serve for "greens," though I found them rather leathery. The fruits of most of the plants are dry and the seeds are small

and contain little nourishment, though they are the chief food supply of the mice and rats and other rock-dwelling animals. Many species store reserve supplies in their thickened roots, from which they spring up quickly in the early summer, but I found none that were palatable or of any value for human food.

Allium pikeanum Rydb. occasionally bears pure white flowers.

Antennaria media Greene. Staminate plants of this species seem to be lacking on this peak, as diligent search in many different localities has failed to discover them.

Chamaenerion augustifolium (L.) Scop. occurs much higher than usually listed. But the colonies seem to spring up from wind-blown seed from below; they flower very late and probably never seed themselves in this zone, although the individuals may live over a winter or two.

Erigeron simplex Greene includes the small erigerons that have been referred to *E. uniflorus* L. as well as the larger forms referred to *E. leucotrichus* Rydb. I was convinced that these apparently different plants were of the same species, and inquiry of Dr. Rydberg brought me the information that *E. uniflorus* L. was not found in Colorado at all and that *E. leucotrichus* Rydb. was an unusually large form of *E. simplex* Greene, to which all these varying forms should be referred.

Gentiana plebeja Cham. [*Amarella plebeja* (Cham.) Greene] varies so as to be almost unrecognizable in some of its forms; occasionally almost white, it runs through many shades of blue and mauve to deep purple, and varies from a robust, branching plant to a single blossom flowering from the ground long after the first snows of autumn.

Lewisia pygmaea (A. Gray) Robins. [*Oreobroma pygmaea* (A. Gray) Howell] I find abundant in damp, gravelly situations rather than on dry mountain sides, as stated by some authors.

Mertensia alpina (Torr.) Don is known locally as "Pikes Peak forget-me-not." There is a rare pure white variety, the widely separated plants bearing all white clusters year after year.

Mertensia ciliata (Torr.) Don includes *M. picta* Rydb. and is the tallest plant above the timber line on Pikes Peak.

Ribes lentum (Jones) C. & R. has, in its alpine form, rosy rather than "greenish" flowers; it is quite a conspicuous plant on the edges but seldom bears fruit above the timber line.

Rhodiola integrifolia Raf. and *R. polygama* (Rydb.) B. & R. are separated with difficulty. While the extremes seem to be distinct, there are, on this mountain at least, many intermediate forms, some dioecious others polygamous, which seem to merge the two species into one. Plants that are polygamous one year may bear either staminate or pistillate heads alone the next season, and polygamous heads were found upon plants which I know bore unisexual flowers the year before.

Rubus strigosus Michx. occurs well above the timber in many places. But while it blossoms freely it rarely matures fruit on account of the early frosts and the depredations of the birds, which no doubt have brought the seeds of the existing plants up from below.

Salix brachycarpa Nutt. is the prevailing willow above the timber line, occurring as dwarfed shrubs well up toward the summit.

COLORADO SPRINGS, COLO.

New Crataegi of the northeastern manual range

W. W. Eggleston

Crataegus schizophylla sp. nov.

A small tree, perhaps 4 m. high, with ascending, irregular branches; spines numerous, 3–7 cm. long; twigs glabrous; leaves oblong-obovate to ovate, 2–6.5 cm. long, 1–4.5 cm. wide, acute or obtuse at the apex, cuneate at the base, coarsely serrate with short acute lobes towards the apex, glabrous, dark green and shining and somewhat impressed-veined above, paler beneath, coriaceous; petioles somewhat winged, 5–15 mm. long; corymbs many-flowered, glabrous, flowers about 12 mm. broad; calyx lobes lanceolate, acute, entire; stamens about 10, anthers pale pink; styles 1–3, surrounded at the base with tomentum; fruit pyriform-ellipsoidal, dark red, about 10 mm. thick; calyx persistent, the lobes reflexed; flesh hard at maturity; nutlets usually 2, ridged on the back.

E. P. Bicknell 15 (type), Job's Neck Cove, Marthas Vineyard, Massachusetts, Oct. 7, 1909. (Herbarium of the New York Botanical Garden.)

The following specimens were used in the description:

Bicknell 10, West Tisbury Road, Edgartown, Marthas Vineyard, Sep. 29, 1909.

Bicknell 12, Chappaquiddick Island, Marthas Vineyard, Sep. 30, 1909.

Bicknell 14, Sengekontacket Pond, Marthas Vineyard, Oct. 1, 1909.

Bicknell, Marthas Vineyard, June 8, 1909. (In flower.)

This species is separated from other members of the section *Crus-galli* by its broad, lobed leaves.

It ranges farther east than any of the other *Crus-galli* do naturally. It ranks with *Crataegus Jonesae* Sarg., of the Maine coast, *Crataegus Bicknellii* Eggl., from Nantucket, and *Crataegus Williamsii* Eggl., from the Flathead basin, Montana, etc., as a good example of an isolated geographical species.

In 1904 Mr. E. P. Bicknell passed over to me fruiting material of a very interesting *Crataegus*. At that time we had no flowers of this species, nor any flowering material from Nantucket, excepting a fragment collected by Miss Mary A. Day, at Wauwinet. This flowering specimen puzzled me, seeming intermediate between Mr. Bicknell's form and typical *C. chrysocarpa* Ashe (*C. rotundifolia* of the manuals). This led me to describe the Bicknell form as a variety of *rotundifolia*. Mr. Bicknell has done much exploring in Nantucket since then, and his material now leads me to consider this *Crataegus* a good species.

Crataegus Bicknellii sp. nov.

C. rotundifolia var. *Bicknellii* Eggl. Rhod. **10**: 79. 4 Je 1908.

A round-topped, shrubby tree, sometimes 3 m. high; spines stout, numerous, 2–6 cm. long; vegetative twigs glabrous; leaves ovate or oblong-ovate, 4–8 cm. long, 3–7 cm. broad, acute at the apex, broadly cuneate or rounded at the base, sharply doubly serrate with acute lobes toward the apex, dark green and shining above, glabrous; corymbs many-flowered, glabrous; flowers about 16 mm. broad; stamens about 10; anthers light purple; calyx lobes long-acuminate, laciniate; styles and nutlets usually 4 or 5; fruit globose, red, about 10 mm. thick; calyx lobes persistent, reflexed, conspicuously lobed; flesh of fruit soft at maturity.

E. P. Bicknell 1 (type), Quidnet (Polpis), Nantucket, Mass., Sep. 5, 1904. (Herbarium of the New York Botanical Garden.)

The following specimens were used in the description:

Bicknell 2, Quidnet, Sep. 5, 1904.

Bicknell 3, Quaise, Nantucket, Aug. 16, 1906.

Bicknell 4, Quaise, Nantucket, Sep. 17, 1907.

Bicknell 5, east of Rattlesnake Bank, Nantucket, June 11, 1908.

Bicknell 6, Shawkemo, Nantucket, June 4, 1909.

Bicknell 7, Quaise, Nantucket, June 9, 1909.

This species differs from *C. chrysocarpa* Ashe in its more sharply lobed leaves and calyx lobes, and its more numerous nutlets.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1905–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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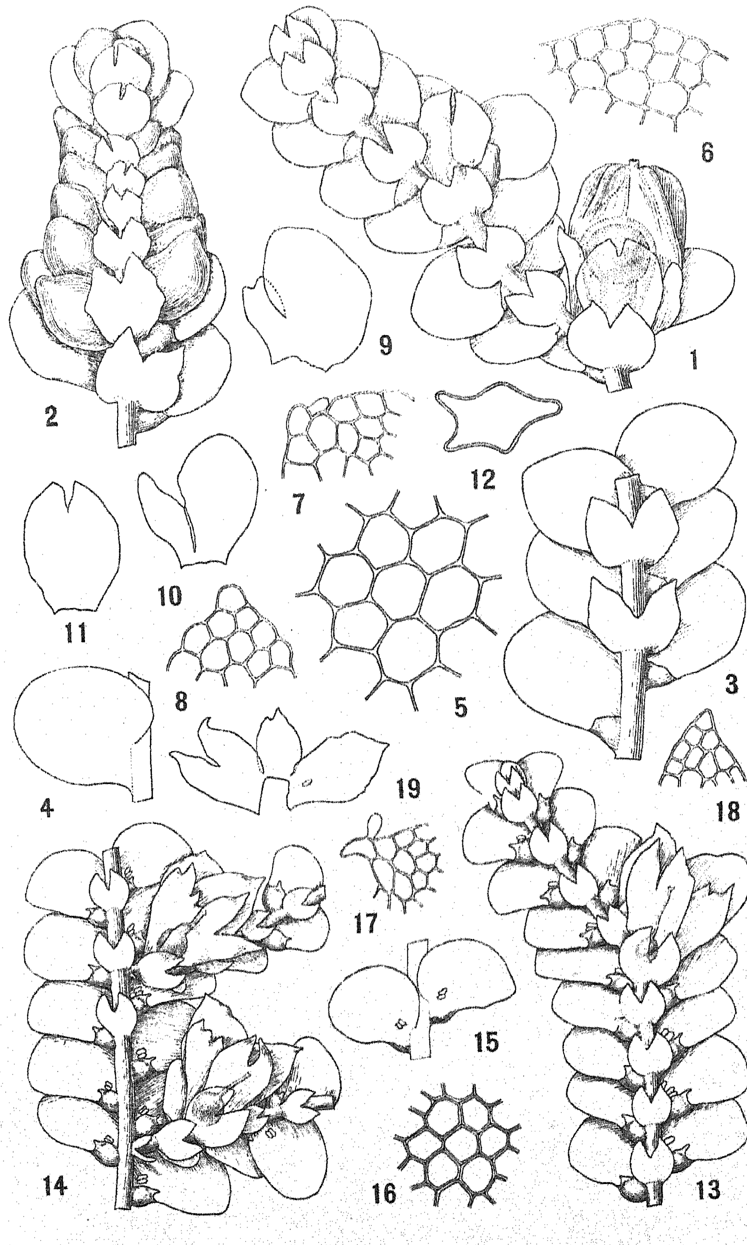
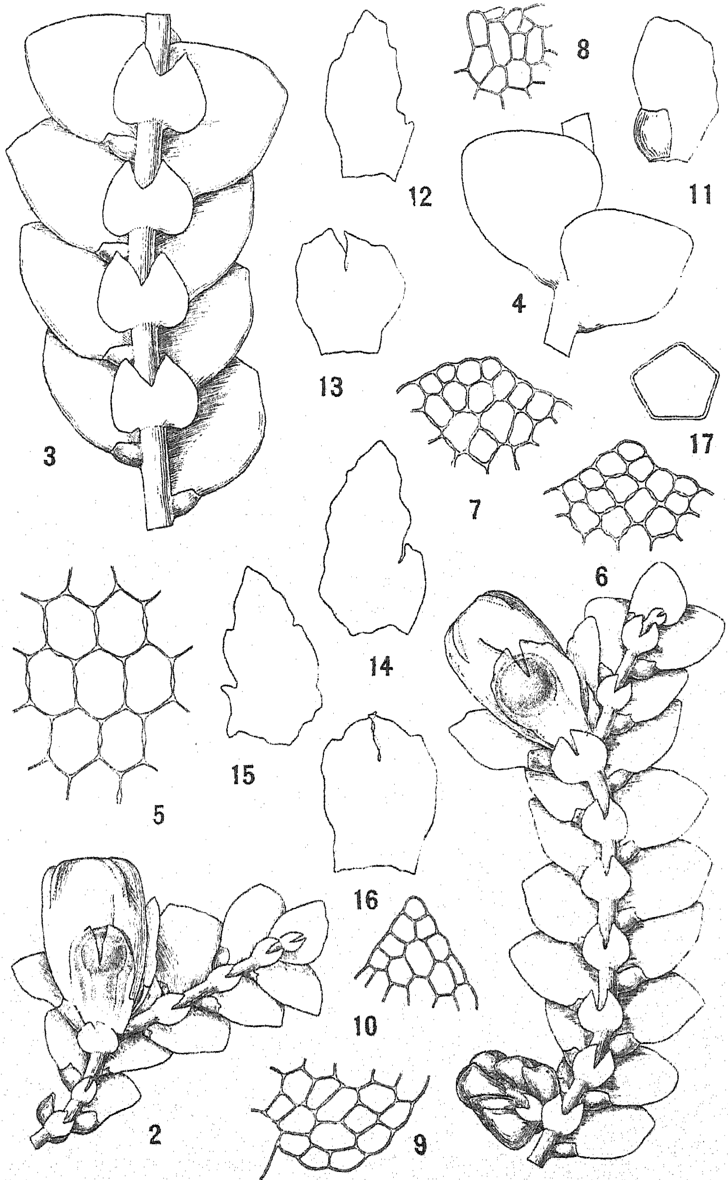


1—12 RECTOLEJEUNEA BRITTONIAE Evans

13—19 CERATOLEJEUNEA INTEGRIFOLIA Evans



TAXILEJEUNEA OBTUSANGULA (Spruce) Evans

Vol. 38 No. 5

BULLETIN

OF THE

TORREY BOTANICAL CLUB

JUNE, 1911

Hepaticae of Puerto Rico

X. COLOLEJEUNEA, LEPTOCOLEA, AND APHANOLEJEUNEA

Alexander William Evans

(with plates 11 and 12)

COLOLEJEUNEA

Although the vast majority of the Lejeuneae develop conspicuous underleaves, there are two recognized genera, *Metzgeriopsis* and *Cololejeunea*, in which underleaves are completely lacking. In fact Leitgeb* has shown that in *Cololejeunea calcarea* (Lib.) Schiffn. the postical segments cut off from the apical cell give rise to no appendages except rhizoids and that the hyaline papillae which usually grow out from these segments, even in the absence of underleaves, are here developed from the lateral segments instead. In all probability the conditions which he describes for *C. calcarea* exist in allied species. The lack of postical appendages is also characteristic of *Radula*, although the relationship between this genus and the Lejeuneae is somewhat remote.

The genus *Metzgeriopsis* contains a single species, the East Indian *M. pusilla* Goebel, and is especially noteworthy for the fact that leaves are borne on the sexual branches only. The vegetative portion of the plant consists of a flat dorsiventral thallus but one cell thick, bearing marginal multicellular hairs and branching in a pinnate manner. The genus *Cololejeunea*, as at present defined, contains about seventy-five species and bears leaves on

* Unters. über Lebermoose 2: 7. 1875.

[The Bulletin for May 1911 (38: 205–250. *pl. 9, 10*) was issued 15 Je 1911.]

both vegetative and sexual axes. Goebel* has demonstrated the fact, however, that in the Lejeuneae, for example in *Lejeunea cavifolia* (Ehrh.) Lindb., the germinating spore develops into a minute and short-lived thalloid structure upon which the persistent leafy plant soon arises. He therefore looks upon *Metzgeriopsis* as a plan in which the embryonic o juvenile stage is long continued.

In his treatment of *Cololejeunea* Schiffner† divides the genus into the two subgenera *Physocolea* and *Leptocolea*, following the example of Spruce.‡ The most important differences between them are to be found in the perianths, the vegetative organs sharing many characters in common. In *Physocolea* the perianth is inflated and usually sharply five-keeled. In *Leptocolea* it is strongly compressed, the antical surface is plane or nearly so, and the postical surface bears a low rounded or two-angled keel. The two subgenera show the same relation to each other, therefore, as the genera *Crossotolejeunea* and *Prionolejeunea*, and the writer suggests that they be considered groups of generic rank. If this is done the name *Cololejeunea* may be retained for the first group, while the name *Leptocolea* may be applied to the second group in a generic sense. The first species which Spruce describes under *Physocolea* is the European *Lejeunea calcarea* Lib.; the first species which he describes under *Leptocolea* is the Peruvian *L. micrandroecia* Spruce. *L. calcarea* may therefore be considered the type of *Cololejeunea* and *L. micrandroecia* the type of *Leptocolea*.

Among the species which Spruce includes under *Physocolea* two distinct types of lobule are represented. The first is well shown by *C. calcarea* and its allies, the second by the European *Lejeunea microscopica* Tayl., a species which finds its closest relatives in tropical and antarctic America. The first type of lobule is found also, with certain modifications, throughout *Leptocolea*. The fact should be emphasized, however, that in these groups as in other genera of the Lejeuneae the lobule is an organ which often fails to develop normally and that a prolonged search is sometimes necessary before characteristic lobules can be demonstrated.

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* Flora 72: 16, 17. *f. 4.* 1889.

† Engler & Prantl, Nat. Pflanzenfam. 1^3: 121. 1895.

‡ Hep. Amaz. et And. 292. 1884.

In the first type of lobule the keel is strongly arched, and it is usually possible to distinguish between a more or less inflated basal portion and an apical portion which is plane or nearly so, although rarely closely appressed to the lobe (PLATE 11, FIGURE 1). The lobule is attached to the stem by an exceedingly short line, and the basal portion of the free margin is more or less involute. The apex is marked by a distinct tooth, usually but by no means always consisting of two cells in a row, and the sinus beyond this tooth is lunulate (FIGURE 5). Somewhere in connection with the apical tooth a hyaline papilla may be demonstrated. It may be at the very apex of the tooth, as in the African *Cololejeunea* (*Leptocolea*) *cuneifolia* Steph.,* but it is much more usual for it to be situated near the base of the tooth, either on the proximal side or on the surface turned toward the lobe (FIGURE 5). Not far from the apical tooth and also on the proximal side a second tooth is usually developed. This is commonly shorter and less definite than the apical tooth, but sometimes the differences between them are not strongly marked. In certain species, for example in the New Zealand *Lejeunea* (*Leptocolea*) *laevigata* Mitt.,† there is even a third tooth between the second tooth and the base of the lobule. A marked deviation in appearance from the lobules just described is to be found in the paleotropic *C.* (*Leptocolea*) *lanciloba* Steph.‡ and in some of its immediate allies. In these the lobule is plane or nearly so, and the apical tooth is represented by a broad and blunt lamina (FIGURE 13). Even here, however, the hyaline papilla is found at the apex of the lobule, and the second tooth is distinct and in its normal position. Such lobules may therefore be regarded as having been derived from the first type.

The lobule of *Lejeunea microscopica* and its allies is built up on an essentially different plan, although agreeing with the first type in having a short line of attachment and an arcuate keel. It is usually larger in comparison with the lobe, and the revolute free margin frequently involves the apex itself. The apical tooth

* Hedwigia 31: 166. *pl. 10.* 1892.

† Fl. Nov. Zeland. 157. 1855.

‡ Hedwigia 34: 250. 1895. See also Evans, Trans. Conn. Acad. 10: 452. *pl. 59. f. 1–7.* 1900.

is represented by a single projecting cell and the second, or proximal, tooth is no better developed, the two being separated from each other by a slight indentation at the bottom of which a single cell of the lobule reaches the margin (PLATE 12, FIGURES 6, 13, and 21. Unless careful dissections are made the two teeth present the appearance of a single tooth, and the apex might readily be described as simply acute. In this type of lobule the hyaline papilla is situated in the lunulate sinus, slightly displaced to the inner or antical surface. It may therefore be described as distal with respect to the apical tooth. The species showing this type of lobule are among the most delicate of the Lejeuneae, and it seems advisable to segregate them from *Cololejeunea* as a distinct genus, to which the name *Aphanolejeunea* may be applied.

What may be a third type of lobule is found in the Javan *Cololejeunea ciliatilobula* Schiffn.* In this species the free margin of the lobule bears a number of hairlike teeth between the apical tooth and the base. Whether this peculiarity is sufficiently distinctive to serve as the basis for further segregation is uncertain; it is possible that it represents nothing more than an extreme manifestation of the tendency noted in *Lejeunea laevigata* to develop accessory proximal teeth. Unfortunately *C. ciliatilobula* is known to the writer from descriptions and figures only.

In its restricted sense the genus *Cololejeunea* contains about twenty known species. It is quite impossible, however, to give more than an approximate estimate because so many have been described from sterile or otherwise incomplete material. It is also very probable that many new species may be expected, both here and in the genera *Leptocolea* and *Aphanolejeunea*. Although the genus is largely tropical its range extends well into Europe and temperate North America. The northern species grow on rocks and on bark. The tropical species occur in similar localities and also on living leaves. Certain species are much less particular about their substratum than others, the North American *C. Biddlecomiae* (Aust.) Evans, for example, growing on both rocks and trees, while the closely allied *C. calcarea* seems to be confined to rocks. The plants are easily overlooked on account of their

* Conspect. Hepat. Archip. Indici 242. 1898. (= *Lejeunea ciliatilobula* Schiffn. Nova Acta Acad. Caes. Leop.-Carol. 60: 239. *pl. 10. f. 11–13.* 1893.)

minute size and also because they frequently occur in admixture with other bryophytes.

The various species of *Cololejeunea* have slender and fragile stems which branch irregularly according to the typical *Lejeunea* type. They cling closely to the substratum by means of rhizoids, which are borne in clusters, one at the base of each leaf. In some cases the leaves are loosely imbricated but it is much more usual for them to be separated. The lobes are attached to the axis along an exceedingly short line which is almost transverse. The same condition is found in *Leptocolea*, *Aphanolejeunea*, and *Diplasiolejeunea* and is in marked contrast to the method of attachment found in most of the other genera of the Lejeuneae, where the line is long and oblique. The lobes exhibit considerable diversity, not only in form but in the finer details of structure. They are more or less convex and spread widely from the axis, which is sometimes partly covered by the arching bases. In outline the lobes vary from broadly ovate to lanceolate, the apex showing all gradations from rounded to acuminate. The margin is usually crenulate or denticulate from projecting cells but is occasionally entire.

The cells of the lobe are sometimes plane and sometimes convex or conical, and the antical surface of the lobe is smooth or rough in consequence. The roughness, however, rarely affects the portion of the lobe which helps enclose the basal water sac but is almost always restricted to a narrow or broad band involving the apical region and perhaps the antical portion as well. The walls of the cells are usually thin and delicate throughout, but in some cases minute trigones are developed and the wall at the tip of a conical cell may also be slightly thickened. Hyaline marginal cells and ocelli, which are characteristic of certain species of *Leptocolea*, are apparently not found in *Cololejeunea*.

The peculiarities of the lobule have already been noted, but another foliar structure, the stylus, should be briefly alluded to. This is situated at the base of the lobule and usually consists of a hyaline papilla only, similar to what is found in the other genera of the Lejeuneae. In many cases, however, the hyaline papilla cuts off a single cell at the base, thus making the stylus two-celled, while in a few species a whole series of cells is cut off and the stylus

may develop into a slender filiform process from two to ten cells long and sometimes two cells wide throughout more or less of its extent. This is the case, for example, in both *C. calcarea* and *C. Biddlecomiae*. The stylus apparently reaches its highest development in *Lejeunea* (*Colo-Lejeunea*) *pseudostipulata* Schiffn.,* of New Guinea, where it forms a broad leaflike appendage, comparable with the stylus found in certain species of *Frullania*.

The inflorescence is autoicous in the majority of the species, but is dioicous in a few. The archegonium is borne on a more or less elongated branch, and the female flower is invariably subtended by one or two innovations. The bracts spread less widely than the leaves, and their lobes are usually smaller and narrower. The lobules are plane and differ more or less from the lobules of the leaves in their apical and marginal teeth. The perianth is typically obovoid and abruptly contracted into a short beak. The five keels are sometimes restricted to the apical region and sometimes extend to below the middle. The cells are similar to the leaf cells but often project in a more conspicuous way especially along the keels. In the male inflorescence the lobules of the bracts are usually larger than in the leaves and are sometimes as large as the lobes. The antheridia are borne singly or in pairs, both conditions being occasionally found in the same species.

The sporophyte is of the type seen in the majority of the Lejeuneae. The small spherical capsule is borne on a short stalk, which has at its base a slightly developed foot. The valves of the capsule are only one cell thick and the cell walls are thickened irregularly. Even the truncate elaters lack the spiral thickenings which are found in most genera, and show irregular thickenings only. The spores are green and variable in form, some being much longer than others. Their walls are slightly thickened and minutely verruculose.

No species of *Cololejeunea* in its restricted sense have been recorded from Puerto Rico. Two species, however, occur in the collections studied by the writer.

Cololejeunea myriocarpa (Nees & Mont.)

Lejeunea myriocarpa Nees & Mont. in Ramon de la Sagra, Hist. Fis. Pol. y Natur. Cuba 9: 473. 1845.

* Leberm. der "Gazelle" Exped. 33. *pl. 7. f. 9–11.* 1890.

Lejeunea epiphyta Gottsche in G. L. & N. Syn. Hep. 391. 1845.
Lejeunea Wrightii Gottsche in Wright, Hep. Cubenses (without description). Stephani, Bot. Gaz. 17: 172. 1892 (*nomen nudum*).
Lejeunea (*Colo-Lejeunea*) *myriocarpa* Steph. Hedwigia **29**: 89. 1890.
Lejeunea (*Cololejeunea*) *heteromorpha* Spruce, Jour. Linn. Soc. Bot. **30**: 348. *pl. 24. f. 5–9.* 1894.

Bright green or yellowish, growing in depressed mats: stems appressed to the substratum, irregularly and often copiously branched, the branches widely spreading, similar to the stem; rhizoids variable in abundance, occurring singly or in small clusters: leaves distant to subimbricated, the lobe obliquely to widely spreading, ovate or semiovate with a rounded or very obtuse apex, averaging about 0.35 × 0.2 mm. (but varying much in size), margin crenulate from projecting cells; lobule usually represented by an indistinct fold, connected with the lobe by a rounded keel, crenulate along the margin except near the base and with an indistinct apical tooth and sinus, hyaline papilla marginal but slightly displaced to inner surface; leaf cells convex, thin-walled throughout, averaging about 14μ along the margin, 18μ in the middle of the lobe, and 22μ at the base: inflorescence autoicous: ♀ inflorescence borne on a more or less elongated branch, innovating on one side, more rarely on both, the innovations often floriferous; bracts similar to the leaves but a little larger, erect-spreading, the lobe 0.45 × 0.25 mm., the lobule a little shorter and narrower with a rounded apex, margin crenulate as in the leaves; perianth obovoid, 0.45 mm. long, 0.3 mm. wide, sharply five-keeled to about the middle, the keels roughened from projecting cells, beak short and broad, often almost obsolete, basal stipe (formed after fertilization) sometimes very conspicuous: ♂ inflorescence very variable in length and in the number and form of the bracts, the latter distant or subimbricated, erect or erect-spreading, in more typical cases subequally bilobed with a strongly arched keel and rounded divisions, the lobule a little shorter than the lobe; antheridia borne singly or in pairs: capsule about 0.2 mm. in diameter; spores greenish, minutely verruculose, about 14μ in short diameter; elaters about 3μ in diameter.

On bark of trees. Near Cayey, *Evans* (*101*). This species was originally described from specimens collected by Ramon de la Sagra at Havana, Cuba, and was afterwards found by Wright on the same island and distributed in his Hepaticae Cubenses. It is known also from St. John (Danish West Indies), *Breutel*

(type of *L. epiphyta*); from St. Vincent, *Elliott* (type of *L. heteromorpha*); from Jamaica, *Evans;* and from Mexico, *Karsten.* The Jamaican specimens grew on rocks but the others were apparently all found on trees. The type specimen of *L. myriocarpa* is preserved in the Montagne herbarium at the Jardin des Plantes, Paris, and that of *L. heteromorpha* in the herbarium of the British Museum, where the Mexican specimens of *L. myriocarpa* are also to be found. The writer has examined these three specimens and finds that they evidently represent the same species and that they agree closely with the plants from Puerto Rico and Jamaica and also with those in Wright's distribution. The specimen of *L. epiphyta* in the Lindenberg herbarium at Vienna was studied by Stephani and referred by him to *L. myriocarpa.* No other stations for the species can be safely quoted at the present time.

It is very difficult to assign definite characters to *Cololejeunea myriocarpa* because the species is not only extremely variable but often presents the appearance of being incompletely or abnormally developed. This is especially true of the lobule, which usually yields characters of great importance in the Lejeuneae. In *C. myriocarpa* there is often nothing more than a mere fold along the postical side of the lobe to represent the lobule, and the keel is sometimes so nearly obliterated that both lobe and lobule are practically in one plane. It is only in the rarest instances that a lobule is found which represents a structure more typical of the genus. In these cases the keel is sharper and a distinct apical tooth, consisting of two superimposed cells, is developed. Even here, however, the proximal tooth is scarcely apparent. The variability which is so manifest in the foliage leaves affects also the perigonial and perichaetial bracts and, to a less extent, the perianth. The cylindrical stipe which develops at the base of this organ after fertilization is largely responsible for the variation in form which it shows. In extreme cases the stipe may equal or exceed the perianth itself and carry it far beyond the bracts, and this condition is connected by intergradations with perianths in which no stipe whatever is formed.

The close relationship which exists between *C. myriocarpa* and *C. minutissima* (Sm.) Schiffn. was fully recognized by Montagne. The two species share so many characters in common that it is

almost impossible to draw sharp distinctions between them, and they rival each other in variability. According to Montagne there are three differences which ought to be especially emphasized. In *C. myriocarpa* he states that the lobule is distinctly shorter than the lobe, that the perichaetial bracts are shorter than the perianth and entire at the apex, and that the mature capsule is oval. In *C. minutissima*, on the other hand, he states that the lobule is about as long as the lobe, that the bracts nearly equal the perianth in length and are distinctly indented at the apex, and that the capsule is spherical. Of course the third difference is based on a misconception. Throughout the Lejeuneae the capsule is spherical, and the oval appearance which it shows after dehiscence (PLATE 12, FIGURE 1) is simply due to the fact that the valves do not quite resume their original position. The other differences given by Montagne are fairly constant, but the distinction between the bracts might be brought out a little more clearly by saying that the lobule in *C. minutissima* is usually definite, the keel being sharp, whereas in *C. myriocarpa* it is usually poorly defined, the keel being rounded or obsolete. It may also be added that the leaf lobes in *C. minutissima* are nearly rotund, while in *C. myriocarpa* they are more elongated. There are still other differences in the gemmae, which will be discussed later on. Whether the true *C. minutissima* occurs in the West Indies is uncertain. It is frequent in southern and western Europe and is also found, in North America, in the Gulf States and along the Atlantic as far north as South Carolina. It has likewise been collected in Bermuda. Its discovery in the Bahamas or in Cuba would therefore not be surprising.

COLOLEJEUNEA DIAPHANA Evans

Cololejeunea diaphana Evans, Bull. Torrey Club 32: 184. *pl. 5. f. 9-14.* 1905.

On leaves of a tree. Three miles east of Santurce, *Heller* (*464*). The type specimens grew on bark in southern Florida and were collected by Small and Carter. No other stations for the species are known.

The specimens from Puerto Rico are very scanty and are referred to *C. diaphana* with considerable hesitation. They are

somewhat more robust than the Florida plants, the leaf lobes measuring 0.45 mm. in length and 0.2 mm. in width. The lobules unfortunately are all in an exceedingly rudimentary condition, so that their typical structure cannot be ascertained. The leaf cells are just a trifle larger than in the type, averaging $28 \times 16\mu$ in the middle of the lobe and 16μ along the margin. In other respects the vegetative organs agree closely. The perianth of the Puerto Rico plant is five-keeled in the upper part, indicating pretty clearly that it belongs in *Cololejeunea*. The only perianth present in the type material is very immature and is more or less compressed, but it is probable that it would present a different appearance when completely developed and would perhaps agree closely with the five-keeled perianth of the Puerto Rico plant. The gemmae of the two specimens are identical in every way. The relationships of *C. diaphana* are discussed in connection with the original description.

LEPTOCOLEA

The genus *Leptocolea* is considerably larger than *Cololejeunea* and includes about fifty known species. Although almost exclusively tropical an occasional species is found in temperate regions. Most of the representatives of the genus are epiphyllous in habit, a few grow on bark, and two or three have been described as creeping over other Hepaticae. Apparently none of the species grow directly on rocks. Although nearly every species is restricted to a particular substratum, this is not always the case, *L. cardiocarpa*, for example, growing on either leaves or bark. The plants rarely form pure mats but are usually badly mixed with other bryophytes.

The species of *Leptocolea* tend to be larger than those of *Cololejeunea*, and firmer in texture, but there are many exceptions to this rule. Most of the statements which have been made about the leaves in *Cololejeunea* will also apply to *Leptocolea*. It should be added, however, that the lobes are much more likely to be rounded at the apex and that the lobules are relatively smaller (PLATE 11, FIGURES 1 and 9). The leaf cells, moreover, exhibit a greater variety. In some cases they equal the cells of *Cololejeunea* in delicacy, but in other cases their walls are thickened, either uniformly or locally. Sometimes the local thickenings are

in the form of trigones only, but intermediate thickenings also are present in certain species (FIGURE 11). The local thickenings may likewise form hyaline warts or spinules on the free outer walls of the cells, usually one in the middle of each cell. In certain species the leaf cells show a higher degree of differentiation than in *Cololejeunea*. Ocelli, for example, may be present or the cells along the margin may become empty and hyaline (FIGURE 12). The stylus, so far as known, consists either of a hyaline papilla or of a slender filament variable in length.

An autoicous inflorescence seems to be the usual type in *Leptocolea*, but in rare instances it may be dioicous, paroicous, or even synoicous. The branch bearing the female inflorescence varies greatly in length but is often much abbreviated (FIGURE 1). It always bears one or two innovations and these may sometimes be floriferous (PLATE 12, FIGURE 1). The bracts show the same characters as in *Cololejeunea*. The perianth varies considerably in different species, although always more or less compressed (PLATE 11, FIGURES 7 and 16). In some cases a very low antical keel and a low two-angled postical keel may be demonstrated, but the antical surface is often plane and the postical keel rounded. The apex of the perianth is broader than the base and varies from rounded to truncate or obcordate. In the last case the short beak appears at the bottom of the apical depression. In the male inflorescence the bracts are sometimes indistinguishable from the leaves (FIGURE 2), but they are often much smaller and have relatively larger lobules (FIGURE 3). Certain species, in fact, show a wide range of variation in the bracts. The sporophyte is essentially like that of *Cololejeunea*. *Leptocolea* may be briefly characterized as follows:

Leptocolea (Spruce) gen. nov.

Lejeunea, subgenus *Colo-Lejeunea*, section *Leptocolea* Spruce, Hep. Amaz. et And. 292. 1884.

Cololejeunea, subgenus *Leptocolea* Schiffn. in Engler & Prantl, Nat. Pflanzenfam. 1^3: 122. 1895.

Plants varying from delicate to robust, pale green, often becoming whitish, yellowish, or brownish with age: stems prostrate, irregularly branched: leaves distant to imbricated, the lobe mostly

plane or nearly so, widely spreading and sometimes arching across the axis, usually ovate to oblong, the apex mostly rounded or bluntly pointed and the margin entire or minutely toothed from projecting cells; lobule (as in *Cololejeunea*) normally inflated at the base and plane or nearly so in outer portion, keel arched, apex with a distinct tooth, hyaline papilla in the vicinity of the apex, variable in position but proximal rather than distal with respect to the apical tooth, free margin bearing a second tooth proximal to the apex, sinus lunulate: underleaves wanting: inflorescence usually autocious: ♀ inflorescence innovating on one or both sides; bracts similar to the leaves but often smaller and with a plane lobule; perianth broadening out from a narrow base, distinctly compressed.

Type species, **Leptocolea micrandroecia** (Spruce) comb. nov. *Lejeunea (Colo-Lejeunea) micrandroecia* Spruce, Hep. Amaz. et And. 298. 1884.

A single species of *Leptocolea*, **L. marginata** (Lehm. & Lindenb.) comb. nov.,* was reported from Puerto Rico by Hampe and Gottsche.† In the Hampe herbarium, now preserved in the British Museum, there is a small packet labeled "*L. marginata*, Porto Rico," with a pencil mark drawn through the specific name. This apparently represents the material upon which the record was based. The packet contains a few plants only, but these show distinct underleaves and belong to the genus *Diplasiolejeunea*, probably to *D. pellucida* (Meissn.) Schiffn., a species with which *L. marginata* was sometimes confused by the older authors. The collections examined by the writer contain four species of *Leptocolea*, one of which seems to be undescribed. The peculiarities of *L. marginata* will be discussed in connection with this new species.

Leptocolea scabriflora (Gottsche)

Lejeunea scabriflora Gottsche, Abh. Bremen Naturw. Ver. 7: 362. 1882 (*nomen nudum*).

Lejeunea erigens Spruce, Hep. Amaz. et And. 298. 1884 (as synonym).

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* *Jungermannia marginata* Lehm. & Lindenb. in Lehmann, Pug. Plant. 5: 11. 1832. *Lejeunea marginata* Lehm. & Lindenb. in G. L. & N. Syn. Hep. 393. 1845. *Lejeunea (Cololejeunea) marginata* Steph. Hedwigia 27: 287. 1888. *Cololejeunea marginata* Schiffn. Conspect. Hepat. Archip. Indici 245. 1898.

† Linnaea 25: 356. 1852.

Cololejeunea erigens Spruce, Hep. Spruceanae. 1892 (name only). Evans, Trans. Conn. Acad. **10**: 450. 1900.

Cololejeunea scabriflora Gottsche in Stephani, Hedwigia 34: 251. 1895.

Pale green or bright green, growing in depressed mats: stems clinging closely to the substratum, 0.07 mm. in diameter, simple to copiously and irregularly branched, the branches widely spreading, usually with somewhat smaller leaves than the stem: leaves distant to loosely imbricated, the lobe widely spreading, somewhat falcate, oblong-ovate to oblong-obovate, very variable in size, reaching a maximum of perhaps 0.7 × 0.45 mm., broad and rounded at the apex, antical margin rounded near the base, arching partially or wholly across the axis, postical margin straight or slightly curved, continuous with the arched keel or showing a shallow indentation at the junction, whole margin (except at the very base) minutely and irregularly denticulate from projecting cells; lobule ovate, 0.25 mm. long and 0.15 mm. wide (on large leaves), inflated in basal region or throughout the greater part of its extent, plane in outer portion, apical tooth usually consisting of two cells in a row, the lower cell bearing the hyaline papilla on its inner surface, proximal tooth shorter and usually consisting of a single blunt or acute projecting cell, separated from the apical tooth by one cell only, sinus shallow, about three cells long; cells of lobe averaging 13μ at the margin, 23 × 17μ in the middle and about 35 × 23μ at the base, thin-walled or with minute trigones and occasional intermediate thickenings, cells in apical region and along margin (in a zone from one to six cells wide) sharply conical and slightly thickened at the apex, remaining cells plane or nearly so: inflorescence autoicous (with occasional male individuals): ♀ inflorescence sometimes borne on a leading branch but usually on a more or less abbreviated branch, in extreme cases bearing no leaves except the bracts, innovating on one side, the innovation sometimes bearing a second female flower, sometimes simple and sterile, sometimes simple and tipped with a male inflorescence; bracts obliquely spreading, complicate, the lobe oblong, about 0.4 mm. long and 0.2 mm. wide, rounded to subacute, irregularly crenulate from projecting cells, lobule oblong, about 0.35 × 0.1 mm., irregularly toothed or lobed at the apex, margin otherwise as in lobe; perianth long-exserted, narrowly obovate, 0.85 mm. long, 0.35 mm. wide, truncate or subretuse at the apex, the upper angles rounded and the beak short, antical surface plane or nearly so, postical keel low and broad, rounded or two-angled in the upper part, the sharp lateral keels minutely denticulate from projecting cells, surface otherwise smooth or nearly so: ♂ inflores-

cence very variable, terminal on a more or less elongated branch and often proliferating at the apex; bracts mostly in from two to six pairs, distant to contiguous, monandrous, sometimes essentially like the leaves but usually smaller, suberect, more equally bifid, the lobe relatively narrower and the lobule more uniformly inflated and frequently with obsolete teeth on the free margin: capsule about 0.2 mm. in diameter; spores greenish, minutely verruculose, about 14μ in short diameter; elaters about 9μ in diameter. (PLATE 11, FIGURES 1–8.)

On leaves of shrubs and trees. Near Cayey, *Evans* (*70, 71,* and *72*, in part). Mayagüez, *E. G. Britton & D. W. Marble* (*536*, in part). Widely distributed in the American tropics and especially abundant in Brazil, where it has been found by numerous collectors. The following localities may also be noted: Trinidad, *Crueger* (the type station); Cuba, *Wright;* Jamaica, *Underwood, Evans;* Andes, *Spruce.*

Spruce referred the present species with some question to *Lejeunea obliqua* Nees & Mont.* and described it fully under this name, quoting his manuscript species, *L. erigens*, as a synonym. A few years later he cast doubt on his earlier determination by distributing specimens under the name *L. erigens*, but apparently he never published this name formally. *L. obliqua* was described from sterile specimens collected by Leprieur in French Guiana. The authors of the Synopsis Hepaticarum considered it a mere synonym of *Lejeunea cuneata* Lehm. & Lindenb.,† which was described from Mauritian plants, also sterile, and Montagne accepted their decision in his Sylloge, published in 1856. Unfortunately no specimens of *L. obliqua* can be discovered in the Montagne herbarium at Paris, and there is therefore no way of deciding whether the French Guiana plant is identical with *L. scabriflora* or not. The writer has also been unable to secure specimens of *L. cuneata* for examination, but a drawing made from the original material and kindly communicated by Stephani shows conclusively that the plant from Mauritius is widely distinct from *L. scabriflora*. The leaves in *L. cuneata*, for example, are much broader and might accurately be described as orbicular-ovate.

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* In Montagne, Ann. Sci. Nat. Bot. II. 19: 264. 1843.

† In G. L. & N. Syn. Hep. 394. 1845. (= *Jungermannia cuneata* Lehm. & Lindenb. in Lehmann, Pug. Plant. 4: 56. 1832.)

It is perfectly safe to say, therefore, that *Leptocolea scabriflora* is not synonymous with *Lejeunea cuneata*, even if its relationship to *Lejeunea obliqua* must be left unsettled.

There are apparently no species very nearly related to *L. scabriflora* in the American tropics, but in Asia, Africa, and the islands of the Pacific several close allies have been discovered. Only two of these will be considered here, **Leptocolea Goebelii** (Gottsche) comb. nov.,* from Java, and **Leptocolea ceatocarpa** (Ångstr.) comb. nov.,† from the Hawaiian Islands. *L. Goebelii* is a little more robust than *L. scabriflora*, the perianth is distinctly obcordate, and the perigonial bracts are diandrous. It is further distinguished by its more coarsely denticulate leaves, the teeth being sharp and irregularly scattered along the greater part of the margin. In *L. ceatocarpa* the lobes of the leaves are narrower than in *L. scabriflora* but the character of the margin is much the same. The Hawaiian species is distinguished further by its diandrous bracts and by its obcordate perianth, although the emargination is less marked than in *L. Goebelii*. In all three species the lobules are essentially the same.

Leptocolea planifolia sp. nov.

Pale green, growing scattered or in depressed mats: stems 0.08 mm. in diameter, closely appressed to the substratum, sparingly and irregularly pinnate, the branches widely spreading, not microphyllous: leaves loosely imbricated, the lobe widely spreading, slightly falcate, ovate to subobovate, 0.75 mm. long and 0.6 mm. wide (on vigorous shoots), broad and rounded at the apex, antical margin arching across the axis, outwardly curved from base to apex, postical margin straight or slightly curved, continuous with the keel or forming a rounded indentation at the junction, margin entire throughout, bordered (except at the base and along the postical side) by from one to three rows of empty hyaline cells; lobule plane throughout or inflated in basal region, narrowly to broadly ovate, about 0.25 mm. long and from 0.12 to 0.17 mm.

* *Lejeunea Goebelii* Gottsche in Goebel, Ann. Jard. Buitenzorg **7**: 49. *pl. 5, 6. f. 54–59.* 1887 (description of gemmae only). *Lejeunea* (*Colo-Lejeunea*) *Goebelii* Schiffn. Nova Acta Acad. Caes. Leop.-Carol. **60**: 240. *pl. 10. f. 1–10.* 1893. *Cololejeunea Goebelii* Schiffn. Conspect. Hepat. Archip. Indici 244. 1898.

† *Lejeunea ceatocarpa* Ångstr. Öfversigt Kongl. Vetensk.-Akad. Förhandl. **29**[4]: 27. 1872. *Cololejeunea ceatocarpa* Steph. Bull. Herb. Boissier **5**: 842. 1897. Evans, Trans. Conn. Acad. **10**: 449. *pl. 57. f. 7–13.* 1900.

wide, apical tooth broad, rounded or retuse at the apex, three to five cells long and three to five cells wide at the base, tipped by two or three cells side by side and bearing a marginal hyaline papilla at their junction, sinus straight or nearly so, free margin more or less involute near base, bearing an acute tooth about midway between base and apex; cells of lobe plane, averaging 16μ along the postical margin, 27 $\times$ 18μ in the middle, and 45 $\times$ 18μ at the base, thin-walled but with minute triangular trigones and occasionally with minute circular intermediate thickenings, hyaline marginal cells thin-walled throughout, a little larger than the adjacent green cells: inflorescence autoicous: ♀ inflorescence sometimes borne on a leading branch, sometimes on a very short branch, innovating on one side, the innovation usually soon floriferous and often repeatedly so; bracts obliquely to widely spreading, the inner one bifid almost to the base, complicate, the lobe as in the leaves but scarcely if at all falcate, 0.75–1 mm. long, 0.45–0.6 mm. wide, lobule ovate, plane, 0.35 $\times$ 0.2 mm. broad and more or less retuse at the apex, margin otherwise entire or vaguely and irregularly sinuate, the proximal marginal tooth rarely apparent; perianth about one third exserted, obovate, 0.75 mm. long, 0.55 mm. wide, broad and retuse at the apex and bearing a short but distinct beak, antical surface plane, postical keel rounded or sometimes two-angled in the upper part, surface smooth or very slightly roughened from projecting cells: ♂ inflorescence occupying a short branch, not proliferating; bracts mostly in from two to four pairs, loosely imbricated, diandrous, without hyaline cells, the lobe rounded and usually revolute at the apex, lobule rotund, rounded at the apex and usually involute along the free margin: capsule 0.25 mm. in diameter; spores (not quite mature) 16μ in short diameter, minutely verruculose. (PLATE 11, FIGURES 8–16.)

On leaves of trees. Utuado, *Howe* (*862*, in part), *E. G. Britton & D. W. Marble* (*882*, in part). No. 882 may be designated the type.

The plant just described is very closely related to *L. marginata*, a species to which reference has already been made. The original *Jungermannia marginata* was described from sterile specimens collected on the island of Mauritius and sent to Lehmann by Presl. A few years later Montagne, under the name *Lejeunea hyalino-marginata* Nees,* listed another plant from Mauritius but gave no diagnosis, so that this name must be regarded as a *nomen nudum*. In the Synopsis Hepaticarum *L. hyalino-marginata* is

* Ann. Sci. Nat. Bot. II. 14: 335. 1840.

quoted under *Lejeunea marginata* as a synonym and the description of the species is amplified so as to include two distinct varieties, one without underleaves and the other with duplicated underleaves. Under the first variety the two Mauritian plants mentioned above are cited; under the second, a single plant from Guadeloupe. The specimen of this second variety in the Lindenberg herbarium consists of two stems, which clearly belong to the genus *Diplasiolejeunea*, so that the true *L. marginata* was known to the authors of the Synopsis from Mauritius only. Later reports of *L. marginata* from the American tropics are also open to suspicion. In addition to the report from Puerto Rico, which has already been disposed of, Gottsche* notes the occurrence of the species in Mexico and Venezuela, and Stephani† cites a specimen from Mexico. The plants quoted by Gottsche are referred by him to his variety *Liebmanniana*, in which the hyaline cells of the leaves are said to be restricted to the apex, so that they are apparently distinct from the true *L. marginata* and also from *L. planifolia* of the present paper. The Mexican specimen which Stephani mentions was collected by Liebmann at Mirador and was referred by Gottsche to *Lejeunea cardiocarpa* Mont. Apparently Stephani has since doubted his determination, because in a recent letter he states that he has seen no *L. marginata* from America, implying at the same time that its discovery here would not be surprising. On the whole, however, in view of the conflicting evidence, it seems wisest to consider that the true *L. marginata* is not yet known on this side of the Atlantic. Even in the Old World its distribution is very inadequately understood. It was reported from Java and Sumatra by Sande Lacoste and from Madagascar by Gottsche, but these seem to be the only new published records.

The writer has been unable to obtain plants of *L. marginata* for study and has again been dependent upon a drawing kindly sent by Stephani. It was made from an African specimen received from Gottsche and presumably of his determination. In this drawing, which shows a portion of the stem with three leaves, the lobule is of the typical *Leptocolea* type. It has a strongly arched

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* Mex. Leverm. 228. 1863.

† Hedwigia 29: 91. 1890.

keel and spreads almost at right angles to the axis, instead of obliquely as in *L. planifolia*. The apical tooth, moreover, is short and sharp and the distinct proximal tooth lies about midway between the base and the outer end of the sinus. According to Gottsche the apical tooth consists of two or three cells in a row. On the evidence derived from this drawing and from the published descriptions *L. marginata* is clearly distinct from *L. planifolia*, and the comparison of specimens would probably show still other differences.

In **Leptocolea lanciloba** (Steph.) comb. nov.,* a species known from the Nicobar and Hawaiian Islands, the Puerto Rico plant has another close ally. In *L. lanciloba* the hyaline margin is a little narrower than in *L. planifolia* and the lobule is still more aberrant. It consists of a slender lanceolate or subulate lamina, subparallel with the axis and gradually tapering to the apex. The latter is sometimes tipped with two cells side by side, sometimes by a single cell, and rarely by two superimposed cells. The hyaline papilla appears either at the apex or close to it on the proximal side of the lobule. A little below the middle the proximal tooth, one or two cells long, is situated. These peculiarities will at once distinguish *L. lanciloba* from *L. planifolia* and also from *L. marginata*. Unfortunately, in the Hawaiian material at least, an occasional lobule is found which approaches in its structure the lobule of *L. marginata*. This condition awakens the suspicion that the remarkable lobule just described is inconstant in its characters and that *L. lanciloba* may perhaps be nothing more than an abnormal form of *L. marginata* or of some other species. The question is one, however, which cannot be answered from the material at hand.

Leptocolea cardiocarpa (Mont.)

Lejeunea cardiocarpa Mont. in Ramon de la Sagra, Hist. Fis. Pol. y Natur. Cuba 9: 476. *pl. 18. f. 4.* 1845.

Lejeunea (*Colo-Lejeunea*) *cardiocarpa* Spruce, Hep. Amaz. et And. 300. 1884.

Pale green, growing scattered or in depressed mats: stems 0.05 mm. in diameter, irregularly branching, the branches widely spreading, similar to the stem: leaves imbricated, the lobe widely

* *Cololejeunea lanciloba* Steph. Hedwigia 34: 250. 1895. Evans, Trans. Conn. Acad. 10: 452. *pl. 59. f. 1–7.* 1900.

spreading, scarcely or not at all falcate, ovate to oblong, 0.75 mm. long, 0.5 mm. wide, rounded at the apex but tipped with a cluster of more or less divergent hyaline cells, antical margin arching a little beyond the axis, outwardly curved from base to apex, sometimes with a few hyaline but not divergent cells, postical margin straight or nearly so, continuous with the keel or slightly indented at the junction, margin entire (except for the hyaline cells at the apex); lobule inflated throughout the greater part of its extent, ovate, 0.17 mm. long, 0.1 mm. wide, apical tooth consisting of two cells in a row or of a single cell, hyaline papilla borne at base of apical tooth on the inner surface, proximal tooth near the apex, obtuse or rounded, sometimes obsolete, keel slightly arched; cells of lobe plane, averaging 14μ along the margin, $18 \times 16\mu$ in the middle, and $30 \times 16\mu$ at the base, thin-walled but with minute local thickenings (as in *L. planifolia*), hyaline cells thin-walled throughout: inflorescence autoicous: ♀ inflorescence usually borne on a more or less elongated branch, rarely on a very short branch, innovating on one side, the innovation often soon floriferous; bracts similar to the leaves, unequally bifid, complicate, the lobe of about the same size as in the leaves, the lobule about 0.2×0.13 mm., crenulate or denticulate in the upper part; perianth about one third exserted, obovate, 0.55 mm. long, 0.4 mm. wide, truncate or slightly retuse at the apex and with an indistinct beak, antical surface plane or nearly so, postical surface with a broad two-angled keel, surface smooth or slightly roughened from projecting cells: ♂ inflorescence occupying a short branch or terminal on a leading branch, not proliferating; bracts mostly in 5 to 15 pairs, imbricated, diandrous, smaller than the leaves, the lobe obliquely spreading, rounded at the apex, lobule half as long or longer, keel strongly arched, crenulate, free margin with a few crenulations at the apex. (PLATE 12, FIGURES 1–3.)

On bark, more rarely on living leaves. North slope of the Luquillo Mountains, *Heller* (*4562*). Three miles east of Santurce, *Heller* (*464*, in part). Seven miles south of Caguas, *Heller* (*288*, in part). Near Cayey, *Evans* (*71*, in small part). Widely distributed in tropical America but rarely abundant. The following localities may also be quoted: Cuba, the type station, *Ramon de la Sagra*; Mexico, *Liebmann*; Brazil, *Spruce*. The type specimen in the Montagne herbarium agrees closely with the Puerto Rico material.

The original description and figures of *L. cardiocarpa* by Montagne are so clear and so complete that it has been possible to add only a few unimportant details. At the same time, in spite of its distinctness, the species has been more or less misunderstood by

writers. Gottsche, for example, in his Mexikanske Levermosser, cites specimens from various Mexican localities, but according to Stephani several of these are referable to other species. The relationship of *L. cardiocarpa* to *L. planifolia* is close, the two species agreeing in the possession of dry and hyaline cells on the margin of the lobe. In *L. cardiocarpa*, however, these cells are usually restricted to the apex of the lobe, and it is only in rare instances that the apical group is supplemented by a narrow band near the antical base. The hyaline cells at the apex usually form but a single row. They are more or less elongated and spread out in a digitate manner, their outer extremities being free from one another and rounded. The hyaline cells near the base are the same in structure but scarcely project beyond the other marginal cells. Apparently hyaline cells of this character play a part in holding the plants firmly to the substratum, as already noted by the writer in connection with the genus *Stictolejeunea*.* In the structure of the lobule, which conforms closely to the *Leptocolea* type, *L. cardiocarpa* differs markedly from *L. planifolia*. The long antheridial branches are also very distinctive, and the lobes of the perigonial bracts usually bear a cluster of hyaline cells at the apex, just as in the leaves. In *L. planifolia* hyaline cells are never found in this position.

Leptocolea Jooriana (Aust.)

Lejeunea Jooriana Aust. Bull. Torrey Club **6**: 20. 1875.
Lejeunea (*Colo-Lejeunea*) *Jooriana* Steph. Bot. Gaz. **17**: 171. 1892.
Cololejeunea Jooriana Evans, Mem. Torrey Club **8**: 173. *pl. 22. f. 9–20.* 1902.

On living leaves. Near Cayey, *Evans* (*71*, in small part, mixed with *L. cardiocarpa* and other epiphyllous Lejeuneae). The original locality for *L. Jooriana* is in Louisiana, but it is now known also from North Carolina, Florida, the Bahamas, and Bermuda. The type specimen grew on reeds but most of the material examined grew on bark. The occurrence of the species on living leaves in Puerto Rico is not surprising since *L. cardiocarpa*, its nearest ally, also grows on both bark and leaves.

A full description of *L. Jooriana*, with figures, was recently published by the writer, as indicated above. In the present paper,

* Bull. Torrey Club **34**: 3. 1907.

therefore, the discussion is restricted to its more important differential characters. The relationship of the species to *L. cardiocarpa* is so very close that the leaves and perianths might be described in almost identical words. The plants differ markedly, however, in their inflorescence, although both are monoicous. In *L. Jooriana* the antheridia are borne, usually singly, in the axils of the perichaetial bracts and occasionally in the axil of the leaf adjacent to the involucre; in *L. cardiocarpa* they are borne, usually in pairs, in the axils of distinct perigonial bracts, which are found on special branches. In consequence of this difference there are further differences in the structure of the perichaetial bracts. In *L. Jooriana* the lobules are inflated much as in ordinary leaves, while in *L. cardiocarpa* the lobules are plane. In well grown plants of *L. Jooriana* the lobules of the leaves are relatively larger than in *L. cardiocarpa*, but this difference is by no means constant. *L. Jooriana* is also characterized by the frequent presence of gemmae, while *L. cardiocarpa* is not yet known to be gemmiparous. Unfortunately this is a difference which it is unsafe to emphasize until the plants are better known. At the present time, therefore, the differences in the inflorescence and in the bracts are the only ones that can be relied upon.

APHANOLEJEUNEA

So far as known at present, about half a dozen species can be referred to *Aphanolejeunea* with certainty. With the exception of the type species, which is known only from the British Isles, the genus is restricted to the tropical and south temperate regions of America. The type species grows on rocks and on bark, often in company with other bryophytes, while most of the American species are epiphyllous in habit. All of them flourish best in very damp localities, on account of their fragile nature.

The stems cling closely to the substratum and branch irregularly. The leaves are usually distant and are never closely imbricated. The lobes spread widely and vary in outline from oblong or ovate to lanceolate, the apex itself varying from rounded to acuminate (PLATE 12, FIGURES 4, 11, and 17). In many cases the lobes are distinctly concave on the antical surface. The lobules, the structure of which has already been described, are

relatively large. As a rule two types of leaves are developed, large and normal leaves with typical lobules and much smaller leaves with rudimentary lobules, and they seem to be unconnected by intermediate types (FIGURES 17 and 18). The leaf cells vary from slightly convex to conical, and none are ever differentiated as ocelli or hyaline cells. Their walls are exceedingly thin and show no trigones, although a strongly conical cell will sometimes show a slight thickening at the apex of the cone. Corresponding with the shape of the cells the margin of the lobe varies from crenulate to denticulate.

A monoicous inflorescence seems to be almost invariably the rule in the genus. Sometimes the male inflorescence is borne on a distinct branch with strongly modified bracts, but it seems to be more usual for the antheridia to be borne in the axils of the leaves below a female inflorescence or even in the axil of one of the perichaetial bracts. Under these circumstances the perigonial bracts are scarcely modified. The female inflorescence always bears one or two subfloral innovations, which may or may not be floriferous. The perichaetial bracts are very much like the leaves, except that the lobules tend to be plane and show differences in the apical region. The perianth is obovoid and inflated, at least near the apex. Sometimes there are no signs of keels; sometimes five keels, more or less marked, can be distinguished. In some cases the beak of the perianth is indistinct or practically obsolete. The sporophyte is essentially like that of *Cololejeunea*. The genus may be characterized as follows:

Aphanolejeunea gen. nov.

Plants very delicate, pale green, often becoming whitish when dry: stems prostrate, sparingly branched: leaves distant to contiguous, the lobe often concave in the outer part, widely spreading, oblong to lanceolate, rounded to acuminate at the apex, the margin usually crenulate or denticulate from projecting cells; lobule inflated, the involute free margin often including the apex, sinus lunulate, apical tooth consisting of a single projecting cell, separated by a slight indentation from the usually less distinct proximal tooth, hyaline papilla distal to the apex, situated in the sinus but slightly displaced to the inner surface, keel arched; cells of lobe uniform, convex to conical, usually thin-walled throughout: underleaves wanting: inflorescence mostly autoicous

or paroicous: ♀ inflorescence borne on a leading branch with one or two innovations; bracts complicate, unequally bifid, the lobe as in the leaves, the lobule plane; perianth obovoid, terete or five-keeled in the upper part, rounded at the apex and abruptly contracted at the apex into a short (sometimes obsolete) beak, surface often roughened from projecting cells. (Name from ἀφανής, invisible, and *Lejeunea*, in allusion to the inconspicuous character of the species.)

Type species, **Aphanolejeunea microscopica** (Tayl.) comb. nov. *Jungermannia microscopica* Tayl. in Mackay, Fl. Hibern. **2**: 59. 1836. *Lejeunea microscopica* Tayl. in G. L. & N. Syn. Hep. 345. 1845. *Lejeunea* (*Colo-Lejeunea*) *microscopica* Spruce, Hep. Amaz. et And. 293. 1884. *Cololejeunea microscopica* Schiffn. in Engler & Prantl, Nat. Pflanzenfam. **1**^{3}: 122. 1895.

Three species that are apparently referable to *Aphanolejeunea* have been reported from Puerto Rico, namely: *Lejeunea sicaefolia* Gottsche, *L. Sintenisii* Steph., and *L. heterophylla* Goebel. The first two are cited by Stephani,* the third by Goebel.† Unfortunately *L. Sintenisii* and *L. heterophylla* are known to the writer from descriptions and figures only, and it seems necessary at the present time to withhold judgment in regard to them. *L. sicaefolia*, however, has been collected in some quantity, and two other species, apparently undescribed, are also present in the material examined.

Aphanolejeunea exigua sp. nov.

Pale green, scattered or growing in thin mats, often mixed with other hepatics: stems zigzag, 0.025 mm. in diameter, usually simple except for the subfloral innovations: leaves distant, obliquely spreading, subsquarrose, the lobe ovate, concave, 0.2 mm. long, 0.1 mm. wide, apex mostly subacute and tipped with a single cell, rarely blunt and tipped with two cells side by side, antical margin spreading widely from the very base, slightly curved, postical margin beyond the keel very short, straight or slightly curved, margin crenulate from projecting cells; lobule ovate, 0.15 mm. long, 0.1 mm. wide, inflated throughout but more strongly so in the basal portion, free margin involute to beyond the apex, the latter tipped with a more or less curved cell or apical tooth, proximal tooth slightly projecting, also consisting of a single cell,

* Hedwigia **27**: 290, 291. *pl. 12. f. 21–24. pl. 13. f. 27.* 1888.

† Pflanzenbiol. Schild. **1**: 178, 179. *f. 79.* 1889.

sinus lunulate, about three cells long, hyaline papilla in the sinus but displaced one cell from the margin, keel arched near base, roughened from conical cells; cells of lobe averaging about 18 × 14μ in the middle, plane to strongly convex or conical, usually thin-walled throughout: inflorescence paroicous: ♀ inflorescence borne on a simple stem (in all observed instances), innovating on one or both sides, the innovations simple and sterile; bracts obliquely spreading, sometimes scarcely complicate, subequally bifid, the lobe ovate, 0.15 mm. long, 0.06 mm. wide, apex and margin as in the leaves, lobule ovate-lanceolate, 0.15 mm. long, 0.05 mm. wide, acute and usually bearing a second sharp tooth on the inner margin near the apex, otherwise entire; perianth obovoid, 0.3 mm. long, 0.25 mm. wide, terete in upper portion, rounded above and bearing a short and broad, sometimes obsolete, beak, surface smooth below, rough in upper half from conical cells: ♂ bracts in a single pair below the involucre, monandrous, otherwise like the normal leaves: capsule about 0.1 mm. in diameter; spores 9μ in short diameter; elaters 5μ wide. (PLATE 12, FIGURES 4–10.)

On living leaves. El Yunque, *Evans* (*21*, in part, mixed with *Cyclolejeunea accedens* and *Drepanolejeunea infundibulata*).

The present species shows the contrast between normal and rudimentary leaves in a very marked way. In a normal leaf the lobule is relatively large and the lobe projects beyond the water sac for only about one fourth its length. The projecting portion is rarely more than three or four cells long and four or five cells broad; it is usually distinctly concave, the margin on each side being curved upward. All the cells in the projecting portion are strongly convex, thus giving the effect of marginal crenulations; in the vicinity of the keel the cells tend to become conical and occasionally show a slight thickening of the wall at the apex of the cone. The free margin of the lobule is appressed to the lobe as far as the apical tooth, which projects slightly beyond the proximal tooth at its base. The rudimentary leaves (not shown on the plate) are scattered about among the normal leaves, and many of the plants fail to show them altogether. The lobes in such leaves are narrow and lanceolate, perhaps four or five cells long and three or four cells broad, and the lobules are often represented by a single cell. Aside from the subfloral innovations branching seems to be exceedingly rare, and there seems to be no

connection between the branches and the rudimentary leaves as in certain other members of the genus.

One of the closest relatives of *A. exigua* is the rare type species, *A. microscopica*, specimens of which have been received from Macvicar. The two species equal each other in delicacy and are of about the same size. The lobes of the leaves are also very much alike and the lobules are almost identical in structure. The two species agree further in their paroicous inflorescence. In *A. microscopica*, however, the cells of the lobes are less strongly convex and the margin consequently is either entire or very vaguely crenulate; along the keel the roughness is better marked although less conspicuous than in *A. exigua*. There are also slight differences in the bracts. In *A. microscopica* the lobes average about 0.25 × 0.09 mm. and the cells near the apex are often distinctly conical instead of merely convex as in *A. exigua*. Sometimes one of the bracts in the British species bears an antheridium in its axil, and the lobe of such a bract is usually less roughened than an ordinary perichaetial bract. The lobule measures about 0.18 × 0.07 mm. and shows two teeth much as in *A. exigua*. The perianths, so far as can be judged from Pearson's description, are very much alike. The differences in the gemmae will be considered later.

Goebel's *Lejeunea heterophylla* has never been formally published, but in his Pflanzenbiologische Schilderungen he alludes to some of its most striking peculiarities and shows them in a figure. The specimen he studied grew on the leaves of *Vittaria remota* in Puerto Rico, but nothing more definite about the locality is stated. According to his account the species is allied to *A. exigua;* it is said, however, to produce leaves with lobules and rudimentary leaves practically destitute of lobules in definite succession and to have a five-keeled perianth. In a letter from Goebel he states that he has preserved no specimens of *L. heterophylla* and would prefer to have the species considered as inadequately published. In any case the five-keeled perianth would serve to distinguish it from *A. exigua*.

In *Lejeunea Sintenisii*, which is known only from the type material collected by Sintenis (*136*), the plants are said to be much branched and to be dioicous. According to Stephani's figure the leaves are similar to those of *A. exigua* except that the lobe projects

for about half its length beyond the lobule and is built up of many more cells, the projecting portion being about eight cells long and six cells wide. The perichaetial bracts, also, are smaller and their lobules are greatly reduced. Neither perianths nor male inflorescences are present in the specimens. It is to be hoped that this species may be again collected so that its characteristics and relationships may become better known.

Aphanolejeunea crenata sp. nov.

Pale green, growing in small mats among other Lejeuneae: stems straight or nearly so, 0.025 mm. in diameter, sparingly and irregularly branched, the branches widely spreading: leaves distant to contiguous, the lobe obliquely spreading, oblong, plane or slightly concave, 0.25 mm. long, 0.07 mm. wide, not falcate, apex obtuse or subacute, tipped with a single rounded cell, antical margin spreading from the base, slightly curved, postical margin beyond the keel straight to slightly curved, margin crenulate from projecting cells; lobule ovate, 0.12 mm. long, 0.07 mm. wide, inflated throughout, free margin involute to apex, apical tooth blunt and slightly curved, proximal tooth rounded, indistinct, each tooth consisting of a single cell, sinus lunulate, about three cells long, hyaline papilla in sinus but displaced one cell from the margin, keel arched, roughened from projecting cells; cells of lobe averaging about $23 \times 16\mu$ near the base, and about 16μ in other parts, more or less convex, thin-walled throughout: inflorescence paroicous (or synoicous): ♀ inflorescence borne on a more or less elongated branch, innovating on one side, the innovation (so far as observed) simple and sterile; bracts erect-spreading to obliquely spreading, complicate, unequally bifid, the lobe as in the leaves, lobule ligulate, about 0.15 mm. long and 0.06 mm. wide, blunt at the apex, margin crenulate in upper part from projecting cells; perianth obovate, 0.35 mm. long, 0.18 mm. wide, inflated above and with faint indications of five keels, each keel being represented by a small group of projecting cells, subtruncate at the apex and with a short beak, surface (except for the rudimentary keels) usually smooth, rarely slightly roughened from scattered projecting cells: antheridia borne singly, usually one in the axil of the leaf below a subfloral innovation and another in the axil of the opposite perichaetial bract; leaves bearing the antheridia much like ordinary leaves: capsule (not quite mature) 0.08 mm. in diameter; elaters from an old capsule 5μ wide. (PLATE 12, FIGURES 11–16.)

On living leaves. El Yunque, *Evans* (*36*, in small part, in company with *Drepanolejeunea Araucariae*, etc.).

The rudimentary leaves in *A. crenata* seem to be confined to the bases of vegetative branches and are not found in a similar position on innovations. They are often only four or five cells long by three or four cells wide and show practically no lobules. Usually only one or two leaves at the base of a branch will show this rudimentary structure. The species rivals *A. exigua* in fragility and agrees with it in possessing a paroicous inflorescence, the only difference being that in *A. crenata* one of the antheridia is commonly borne in the axil of a perichaetial bract. When compared further with *A. exigua* the lobes of the leaves are found to be plane or nearly so, to have their margins practically parallel, and to project for about half their length beyond the lobules. *A. crenata* differs also in the structure of the perianth, which is not only narrower than in *A. exigua* but is smoother in the upper part, the roughness being often confined to the indistinct keels. The fact that only one subfloral innovation is produced should also be emphasized. Unfortunately the species was collected in very small quantity.

Aphanolejeunea sicaefolia (Gottsche)

Lejeunea sicaefolia Gottsche, Abh. Bremen Naturw. Ver. 7: 362. 1882 (*nomen nudum*).

Lejeunea (*Cololejeunea*) *sicaefolia* Gottsche in Stephani, Hedwigia 27: 290. *pl. 12. f. 21–24.* 1888.

Pale green, scattered among other hepatics or growing in loose depressed mats: stems not zigzag, 0.025 mm. in diameter, sparingly and irregularly pinnate, the branches widely spreading, similar to the stem: leaves distant, obliquely to widely spreading, the lobe lanceolate, slightly falcate, 0.4 mm. long, 0.1 mm. wide, somewhat concave and often variously curved and contorted in outer part, apex acuminate, usually tipped with a row of two or three cells, antical margin spreading from the base, slightly curved, postical margin beyond the keel straight or nearly so, margin (except at the very base) denticulate or crenulate from projecting cells; lobule ovate, 0.17 mm. long, 0.1 mm. wide, similar to that of *A. exigua;* cells of lobe averaging 14μ at the margin and 30 $\times$ 14μ in median and basal regions, conical, thin-walled throughout or with a slight thickening at the apex of the cone: inflorescence autoicous: ♀ inflorescence borne on a more or less abbreviated branch, innovating on one side, more rarely on both, the innova-

tions sterile or soon again floriferous; bracts obliquely spreading, more or less complicate, the lobe as in the leaves but usually a little smaller, measuring about 0.35 × 0.07 mm., lobule ovate, 0.17 mm. long, 0.03 mm. wide, bidentate at the apex, otherwise subentire; perianth obovoid, 0.4 mm. long, 0.2 mm. wide, rounded at the apex and bearing a short beak, inflated and five-keeled in the upper part, the keels sharply denticulate from high-conical cells, surface between the keels sometimes smooth but usually more or less roughened like the keels: ♂ inflorescence occupying a short branch or terminal on a longer branch, rarely proliferating; bracts contiguous but scarcely imbricated, the lobe as in the leaves but shorter and narrower, lobule reduced to a small basal fold; antheridia borne singly: capsule about 0.1 mm. in diameter; spores 9μ in short diameter; elaters 5μ wide. (PLATE 12, FIGURES 17–26.)

On leaves and logs. Without definite locality, *Sintenis* (*4*). North slope of the Luquillo Mountains, *Heller* (*4647*, in part). El Yunque, *Evans* (*13*). The species is also known from Cuba, *Wright*, *Underwood*, and from Trinidad, *Crueger*. Although Gottsche first applied the name *Lejeunea sicaefolia* to the plant from Trinidad, the specimen collected by Sintenis should be regarded as the type of the species, because it was from this that the first published description was drawn. The determination of the specimens described above was confirmed by Stephani.

Rudimentary leaves are very frequent in *A. sicaefolia*. The leaves subtended by branches seem to be invariably of this type, and the same is true of the leaves at the base of a vegetative branch. These statements, however, do not apply to perichaetial bracts and subfloral innovations. In many cases, also, rudimentary leaves are scattered irregularly among normal leaves and show no connection with branches. In a well developed leaf the lobe is more than three times the length of the lobule. In the basal part, where it helps to form the water sac, it is plane or nearly so, but the free apical portion is usually irregularly curved or twisted and also distinctly concave, the antical margin being curved in such a way that the marginal denticulations extend upward instead of outward. In typical cases the interior cells of the free portion resemble the marginal cells in being conical and often show a slight thickening of the wall at the apex of the cone, but these conical cells may be few or absent altogether and are

never found in the portion of the lobe which covers over the water sac. The lobule is inflated throughout its entire extent and the free margin lies in contact with the lobe as far as the proximal tooth. This is usually a little more prominent than the apical tooth, which rarely shows clearly without flattening out the lobule. In the rudimentary leaves the lobe is shorter and narrower than in normal leaves and is sometimes reduced to a width of only two or three cells. The lobule in such leaves is merely a minute basal fold, sometimes consisting of a single cell. The perigonial bracts are also much more rudimentary in structure than in normal leaves and in extreme cases may be even shorter than the leaves just described. These bracts can afford but little protection to the antheridia, which at maturity often exceed their lobes in width. According to Stephani the perianth of *A. sicaefolia* is destitute of keels but the perianths he studied, according to his figure, were very immature. In mature perianths the five keels are sometimes apparent, but are often difficult to demonstrate when the faces between them are roughened in the same way.

The lanceolate acuminate lobes and the autoicous inflorescence, together with the small perigonial bracts, will at once serve to distinguish *A. sicaefolia* from the two preceding species. A closer relative is apparently the Brazilian *Lejeunea* (*Colo-Lejeunea*) *liliputiana* Spruce,* known to the writer from description only. This species, which is also autoicous, is even smaller than *A. sicaefolia*, the leaves being only 0.15 mm. long. It is characterized further by the obtuse lobes of its leaves and by its smooth perianth.

THE GEMMAE OF COLOLEJEUNEA, LEPTOCOLEA, AND APHANOLEJEUNEA

The remarkable discoid gemmae found in the genus *Cyclolejeunea* were described by the writer several years ago.† Each one arises from a marginal cell of a leaf lobe, and the stalk cell from which it becomes separated at maturity is attached to its basal edge. The three genera treated in the present paper also develop discoid gemmae, but these differ primarily from the gemmae of *Cyclolejeunea* in being borne on the surface of the leaf lobes instead

* Hep. Amaz. et And. 297. 1884.

† Bull. Torrey Club 31: 205–210. *pl. 9, 10.* 1904.

of on the margin. In consequence of this position the stalk cell becomes displaced, as it were, from the margin to the surface of the gemma but is always eccentrically attached. Since the gemmae in *Cololejeunea* are essentially like those in *Leptocolea* and *Aphanolejeunea*, the three genera will be considered together. In some species gemmae are very abundantly produced, while in others they are much more sparingly developed. It is probable in fact that certain species are never gemmiparous, but it would be premature to make a statement to this effect about many individual species at the present time. The production of gemmae is not accompanied by any striking modifications in leaf structure or by any marked limitation of growth.

The structure and development of the gemmae have been described more or less fully by Goebel in *Leptocolea Goebelii*,* by Stephani in **Leptocolea cuneifolia** (Steph.) comb. nov.,† by Cavers in *Cololejeunea calcarea*,‡ and by Stevens in *C. Biddlecomiae*.§ Stevens showed that the gemmae of *C. Biddlecomiae* and *C. calcarea* pursued essentially the same course of development as that described by Goebel for the gemmae of *L. Goebelii* and explained the slight discrepancies to be found in Cavers's account of *C. calcarea*. The writer has been able to study the gemmae in five species of *Cololejeunea*, nine of *Leptocolea*, and two of *Aphanolejeunea* and finds that all agree closely in their development with the species discussed by Stevens. According to his account the leaf cell which is to form a gemma projects beyond its neighbors and divides by a wall parallel with the surface of the leaf. The outer cell represents the mother cell of the gemma, while the inner cell becomes the stalk. The mother cell then proceeds to divide by a series of walls perpendicular to the leaf surface, and the resulting gemma consists in consequence of a plate of cells one cell thick. The first wall divides the mother cell into two semicircular cells, and the subsequent divisions which take place in these cells are the same, thus making the mature gemma symmetrical with respect to the median plane. The two semicircular cells are first divided

* Ann. Jard. Buitenzorg 7: 240. 1887.

† = *Lejeunea* (*Cololejeunea*) *cuneifolia* Steph. Hedwigia 30: 167. *pl.* 10. 1892.

‡ New Phytol. 2: 160. *f.* 8. 1903.

§ Bull. Torrey Club 37: 366–369. *f.* 1. 1910.

into approximately equal quadrants. Then, as Stevens goes on to show, the two apical quadrants grow more rapidly than the two basal quadrants, thus forcing the wall between them into an oblique position with respect to the median walls. The two apical quadrants function as apical cells, the first segment in each being cut off by a wall parallel to the median wall. The segments undergo further divisions, the first walls being always periclinal. The basal quadrants also become subdivided in much the same way as the oldest segments. The eccentrically situated stalk cell is approximated more or less to the basal margin (TEXT FIGURE 2, *C*, *D*), and the gemma becomes free by a splitting of the walls by which it is attached to the stalk cell.

When the gemmae of various species are compared it is found that they differ in size and in the number of cells of which they are composed, but that, for a given species, the number of cells is fairly constant. The differences in the number of cells are due primarily to the number of segments cut off by the apical quadrants and secondarily to the number of subsequent divisions which take place in the segments and in the basal quadrants. In the simplest gemmae only two segments are cut off, each of which divides once, while each of the basal quadrants divides into three cells, the first division being by the usual periclinal wall and the second by an anticlinal wall in the outer cell. These divisions give rise to a gemma composed of sixteen cells, a condition seen clearly in *Aphanolejeunea microscopica*, *A. exigua*, *Cololejeunea myriocarpa*, and *C. Macounii* (Spruce) Evans;* occasionally, in *C. myriocarpa* at least, one or both of the younger segments fail to divide, so that the mature gemma consists of only fourteen or fifteen cells. It will be seen that gemmae of this type tend to be symmetrical with respect to a transverse median plane as well as a longitudinal plane (TEXT FIGURE 1, *A–C*; PLATE 12, FIGURE 10).

The cutting off of three segments takes place in the gemmae of *Cololejeunea calcarea*, *C. Biddlecomiae*, **Leptocolea ovalifolia** (Evans) comb. nov.,† and *L. cuneifolia* (TEXT FIGURE 1, *D*, *E*).

* Mem. Torrey Club 8: 171. *pl. 22. f. 1–8.* 1902. *Lejeunea* (*Cololejeunea*) *Macounii* Spruce in Underwood, Bull. Torrey Club 17: 259. 1890. The species is probably a *Leptocolea*, judging from its vegetative structure; unfortunately mature perianths have not been seen by the writer. It is known from British Columbia only.

† = *Cololejeunea ovalifolia* Evans, Trans. Conn. Acad. 10: 450. *pl. 58. f. 1–6.* 1900. Known from the Hawaiian Islands only.

This is usually accompanied by a more vigorous cell division and gives rise to gemmae composed of from twenty to twenty-four cells. In the gemmae of *Cololejeunea diaphana* there are also only three segments cut off as a rule, the number of cells at maturity being twenty. In one instance, however, a gemma was observed in which one of the apical quadrants had cut off four segments and in which the total number of cells was twenty-two (TEXT FIGURE 1,

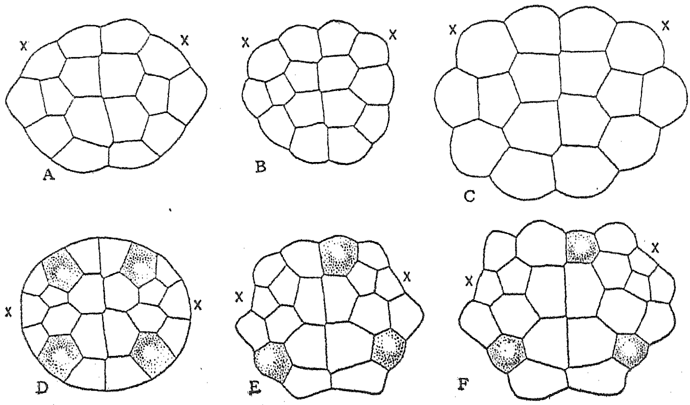

FIGURE 1. Gemmae, × 300. The apical cells are indicated in the usual way. A. *Aphanolejeunea microscopica;* Argyllshire, Scotland, *Macvicar.* B. *Cololejeunea myriocarpa;* near Cayey, Puerto Rico, *Evans* (*101*). C. *C. Macounii;* British Columbia, *Macoun* (Hep. Amer. *177*). D. *Leptocolea ovalifolia;* Oahu, Hawaiian Islands, *Cooke.* E. *L. cuneifolia;* Kamerun, *Dusén* (Hep. Afr. *501*). F. *Cololejeunea diaphana;* near Santurce, Puerto Rico, *Heller* (*464*).

F). In the gemmae of *Cololejeunea minutissima*, *Leptocolea Jooriana*, and *L. scabriflora* four segments are cut off (TEXT FIGURE 2, *A*, *B;* PLATE 11, FIGURE 8). In *C. minutissima* the subsequent divisions are very numerous and gemmae with as many as thirty-four cells are sometimes found. In the other two species the number of cells seems to be pretty constantly twenty-four. The most complicated gemmae, in which five segments are cut off, are found in four species of *Leptocolea*, namely: *L. lanciloba*, **L. longistylis** (Evans) comb. nov.,* *L. ceatocarpa*, and *L. Goebelii* (TEXT FIGURE 2, *C*, *D;* 3, *A*, *D*). In the first two, where the cell division is especially active, the mature gemmae are composed of forty

* = *Cololejeunea longistylis* Evans, Trans. Conn. Acad. **10:** 453. *pl. 59. f. 8–16.* 1900. Known from the Hawaiian Islands only.

or more cells; in *L. ceatocarpa* the number of cells is usually thirty-eight, while in *L. Goebelii* it is only thirty,—fewer than in *C. minutissima*, in which only four segments are cut off.

Aside from the differences in the number of segments and in the number of cells present at maturity, the gemmae of different species are characterized by peculiarities of the marginal cells, by the presence or absence of "Haftorgane," or organs of attachment, and by the number and situation of these organs. With regard to the margin there are certain species in which none of the marginal

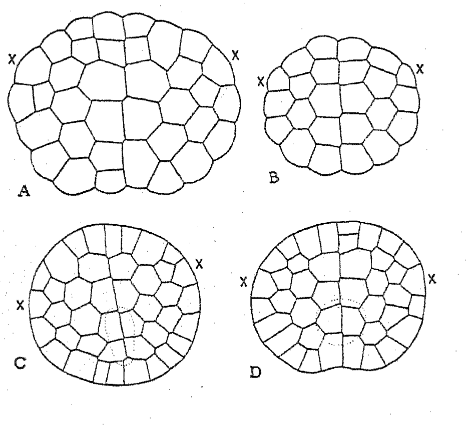

FIG. 2.

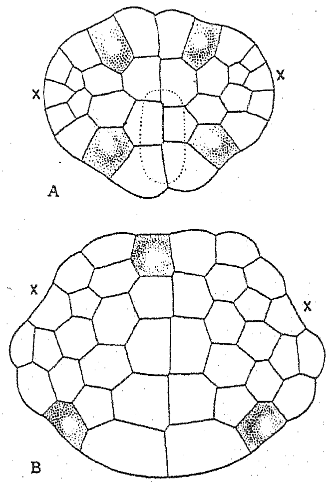

FIG. 3.

FIGURE 2. Gemmae, × 300. A. *Cololejeunea minutissima;* Florence, Italy, *Levier*. B. *Leptocolea Jooriana;* Lisbon, Florida, *Underwood* (95). C. *L. lanciloba;* Oahu, Hawaiian Islands, *Cooke*. D. *L. longistylis;* Oahu, Hawaiian Islands, *Cooke*.

FIGURE 3. Gemmae, × 300. A. *Leptocolea Goebelii;* Tjibodas, Java, *Fleischer*. B. *L. ceatocarpa;* Hawaiian Islands, *Heller* (2562).

cells project. This is true, for example, of *L. lanciloba*, *L. longistylis*, and *L. ovalifolia*, and the margin in these may be described as perfectly entire. It is much more usual, however, for some or all of the cells to project in the form of crenulations or denticulations, according to whether they are convex or conical. In gemmae with convex cells, the margin is sometimes crenulate throughout as in *Cololejeunea myriocarpa*, *C. minutissima*, *C. Macounii*, and *Leptocolea Jooriana*. In *L. ceatocarpa*, however, only the marginal

cells of the younger segments project, while in *L. Goebelii* the cells bounding the median wall are the only ones affected. In gemmae with marginal denticulations it is always certain special cells that project and these are always definite in position. The outer cell of the youngest segment is the one most certain to show this condition, as in *Aphanolejeunea microscopica*, but it is not usual for this cell to be the only one that projects. In *A. exigua*, for example, the two basal cells and the opposite one on one side also project, and this statement will apply equally well to *Cololejeunea diaphana* and *Leptocolea cuneifolia*, where more segments are cut off.

The remarkable organs of attachment are fully described by Goebel in the case of *Leptocolea Goebelii*. They represent marginal cells which project at right angles to the two surfaces of a gemma. At their extremities they secrete a slime which enables the gemma to attach itself to the substratum. These organs of attachment are not found in all species and are most frequent in the epiphyllous species of the tropics. Of the sixteen species studied by the writer seven develop such organs, while the others lack them completely. When present they are not only constant in number for a given species but also constant in position. In *Leptocolea Goebelii* and *L. ovalifolia* four organs of attachment are developed; in *L. ceatocarpa*, *L. scabrifolia*, *L. cuneifolia*, *Cololejeunea diaphana*, and *Aphanolejeunea exigua* there are only three. When four are present two are developed from the basal quadrants and two from the first segments cut off from the apical quadrants. In each of these a periclinal wall is first formed in the usual way and then the outer cell divides again by an anticlinal wall. Of the two marginal cells thus formed the one farther from the median wall becomes modified into the organ of attachment. When only three organs are present two are developed from the basal quadrants, which divide in the way just described.* The third is formed from the first segment on one side. This divides by the usual periclinal wall and then the outer of the two cells thus formed becomes modified into the organ of attachment without undergoing a preliminary anticlinal division. For this reason the organ is situated

* In *L. ceatocarpa* the division goes one step farther, the cells which would naturally be expected to develop into organs of attachment first dividing by periclinal walls.

next the median wall. The corresponding segment on the other side of the gemma divides in the same way but the outer cell does not become modified. It will be seen at once that when three organs of attachment are present the gemma shows a condition of slight asymmetry, in spite of the fact that the cells on each side of the median wall are alike in number and position. When four organs are present the condition of symmetry is maintained.

Although the gemmae in the Lejeuneae have been but little studied by taxonomists it will be seen from the above account that they present characters of great constancy. They can often, in fact, be used in the determination of specimens which are sterile or otherwise imperfectly developed. This is true, for example, of the closely related *Cololejeunea minutissima* and *C. myriocarpa*, where the lobules are usually either rudimentary or abnormally developed. To summarize what is known about the Puerto Rico species it may be stated that only five of the species described in this paper have been proved to be gemmiparous. In the gemmae of two of these, *Cololejeunea myriocarpa* and *Leptocolea Jooriana*, no organs of attachment are present and the margin is crenulate throughout; in the other species, *C. diaphana*, *L. scabriflora*, and *Aphanolejeunea exigua*, the gemmae develop three such organs and only certain of the marginal cells project. With regard to the number of segments cut off by the apical quadrants, *A. exigua* and *C. myriocarpa* have only two, *C. diaphana* almost invariably has three, while *L. scabriflora* and *L. Jooriana* have four.

The germination of the gemmae was studied by Goebel in the case of *L. Goebelii*. He found that the apical cells first cut off a series of segments but that very soon one of them gave rise to the leafy shoot, and he considered that the tetrahedral apical cell of the stem was cut out directly from the two-sided apical cell of the gemma. Occasionally he saw the leafy plant arise from one of the cells next the median wall between the two basal organs of attachment. The writer has been able to confirm these observations but can add very little to them. It may perhaps be of interest to note, however, that in gemmae with three organs of attachment the leafy shoot usually arises from the apical cell on the side with two such organs.

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Explanation of plates 11 and 12

As in the previous papers of this series the figures were drawn by the writer, and most of them were prepared for publication by Miss Edna L. Hyatt.

PLATE 11

Leptocolea scabriflora (Gottsche) Evans. 1. Part of stem with two fertile branches and a male inflorescence, postical view, × 35. 2. Apex of branch with antheridia, postical view, × 35. 3. Apex of a typical perigonial spike, postical view, × 35. 4. Cells from margin of lobe near apex, × 265. 5. Part of lobule, showing apical and proximal teeth, × 200. 6. Perichaetial bract, × 45. 7. Transverse section of perianth near apex, × 45. 8. Gemma, × 265. The figures were all drawn from specimens collected by the writer (*72*, in part).

Leptocolea planifolia Evans. 9. Part of plant with four female inflorescences (including two perianths), postical view, × 25. 10. Part of plant with a male and a female inflorescence, postical view, × 35. 11. Cells from middle of lobe, × 265. 12. Cells from apex of lobe, × 200. 13. Apical part of lobule, × 200. 14, 15. Perichaetial bracts, × 35. 16. Transverse section of perianth, × 45. The figures were all drawn from specimens collected by M. A. Howe (*862*, in part).

PLATE 12

Leptocolea cardiocarpa (Mont.) Evans. 1. Part of plant with three perianths and an old capsule, postical view, × 35. 2. Part of plant with male inflorescence, postical view, × 35. 3. Apical part of lobule, × 200. The figures were all drawn from specimens collected by A. A. Heller (*288*, in part).

Aphanolejeunea exigua Evans. 4. Apex of plant with perianth, postical view, × 55. 5. Apex of lobe, × 200. 6. Apex of lobule, × 200. 7. Perichaetial bract, ×55. 8. Apex of lobule of bract, × 200. 9. Cells from apical part of perianth in optical section, × 200. 10. Gemma, × 265. The figures were all drawn from the type specimen.

Aphanolejeunea crenata Evans. 11. Part of plant with perianth, postical view, × 55. 12. Apex of lobe, × 200. 13. Apex of lobule, × 200. 14. Perichaetial bract, × 55. 15. Transverse section of perianth in lower part, × 55. 16. Cells of perianth in section, × 200. The figures were all drawn from the type specimen.

Aphanolejeunea sicaefolia (Gottsche) Evans. 17. Part of plant with perianth, postical view, × 55. 18. Part of stem with two branches, postical view, × 55. 19. Part of a male inflorescence, postical view, × 200. 20. Apex of lobe, × 200. 21. Apex of lobule, × 200. 22, 23. Perichaetial bracts, × 45. 24. Perianth, antical view, × 55. 25. Transverse section of perianth in apical portion, × 55. 26. Transverse section of perianth nearer the base, × 55. The figures were all drawn from specimens collected by the writer (*13*).

List of lichens collected in the Yukon region by Mr. R. S. Williams

R. Heber Howe, Jr.

During the winter of 1910 Mr. R. S. Williams sent me a duplicate set of lichens which he had collected in the Yukon region in 1898 and 1899. Mr. T. A. Williams had examined the collection several years before and determined a large number of them, but his work had been only casual and he professed no critical study of the material. Both Mr. T. A. Williams and Miss C. E. Cummings were given duplicate sets, though Miss Cummings' was incomplete. I forwarded the crustose species at once to Dr. H. E. Hasse of Sawtelle, Cal., and the specimens of *Cladonia*, *Stereocaulon* and *Baeomyces* to Dr. L. W. Riddle of Wellesley College, who also lent his aid on several species of other genera, while I have studied the remaining foliaceous and filamentous species. One unusual *Cladonia* bearing a new manuscript name given by Mr. T. A. Williams I sent to Dr. L. Scriba of Germany. To all these gentlemen grateful thanks are due.

Family SPHAEROPHORACEAE

1. *Sphaerophorus coralloides* Pers. *No. 32*, Sheep Camp, Dyea Cr., Mar. 1898, fertile; *no. 70*, above Lake Lindeman, May 20, 1898, sterile.
2. *Sphaerophorus fragilis* (Crantz) Pers. *No. 90*, Lake Lindeman, May 5, 1898, sterile.

Family ARTHONIACEAE

3. *Arthonia* (*Allarthonia*) *patellulata* var. *alnicola* Nyl. *No. 62*, Dawson, Mar. 1899, fertile.

Family LECIDACEAE

4. *Buellia papillata* (Sommf.) Tuck. *No. 86*, Lake Lindeman, May 15, 1898, fertile.
5. (?) *Buellia scabrosa* (Ach.) Koerb. *No. 79*, Lake Lindeman, May 28, 1898, fertile. "Probably correct—scanty, about all used up in making examinations."—Hasse.

6. *Lecidea platycarpa* Ach. *No. 53*, Dawson, Apr. 1899, fertile.
7. *Lecidea contigua* var. *hydrophila* Fr. *No. 59*, Lake Lindeman, May 1898, fertile.
8. *Lecidea* (?) 1 specimen, *no. 52*, "too fragmentary for a satisfactory examination."—Hasse.
9. *Heterothecium sanguinarium* (L.) Flot. *No. 85*, Sheep Camp, Dyea Cr., Apr. 1898, fertile.
10. *Biatora cinnabarina* (Sommf.) Fr. *No. 61*, Lake Lindeman, Apr. 1898, fertile.
11. *Biatora* (*Catillaria*) *franciscana* Tuck. *No. 56*, Lake Lindeman, May 9, 1898, fertile.
12. *Biatora* (*Bacidia, Bilimbia*) *sphaeroides* (Dicks.) Tuck. *No. 48*, May 7, 1899, fertile.
13. *Baeomyces aeruginosus* (Scop.) DC. *No. 24*, Lake Lindeman, May 1898, fertile.

Family CLADONIACEAE

14. *Cladonia digitata* (L.) Hoffm. *No. 12*, Lake Lindeman, Mar. 1898, fertile.
15. *Cladonia bellidiflora* var. *coccocephala* (Ach.) Wain. *No. 10*, Lake Lindeman, May 1898, fertile.
16. *Cladonia coccifera* (L.) Willd. *No. 98*, Lake Lindeman, May 1898, fertile.
17. *Cladonia coccifera* var. *pleurota* (Flk.) Schaer. *No. 11*, Lake Lindeman, May 1898, fertile.
18. (?) *Cladonia uncinalis* (L.) Web. *No. 94*, Lake Lindeman, May 12, 1898. Badly broken. "Chopped."—Riddle.
19. *Cladoniar angiferina* (L.) Web. *No. 3*, Lake Lindeman, May 1898, sterile.
20. *Cladonia furcata* var. *scabriuscula* (Del.) Coem. *No. 8*, Lake Lindeman, May 1898, fertile.
21. *Cladonia rangiformis* Hoffm. *No. 7*, Lake Lindeman, May 1898. "No reaction with KOH."—Riddle.
22. *Cladonia crispata* (Ach.) Flot. *No. 1*, Lower Klondike River, May 1899, fertile.
23. *Cladonia crispata* var. *subcrispata* (Nyl.) Wain. *No. 9*, Lake Lindeman, May 1898, fertile.
24. *Cladonia pyxidata* var. *neglecta* (Flk.) Wain. *No. 4*, Dawson, Apr. 1899, fertile.

25. *Cladonia cariosa* (Ach.) Spreng. *No. 5*, Lake Lindeman, May 1898, fertile. This specimen approaches var. *squamulosa* (Müll.) Wain.

26. *Cladonia cariosa* f. *majuscula* Del. *No. 80.* Dawson, May 1898, fertile. This plant was labeled by Mr. T. A. Williams *Cladonia cariosa Dawsoniana* var. nov. I forwarded it to Dr. Scriba who, though hindered by the limited material, writes in litt. Jan. 8, 1911—"with good probability I determine this plant as *C. cariosa* f. *majuscula* Del." (Duby, Bot. Gall. **2**: 632. 1830), and proceeds to discuss the case at length.

27. *Philophorus cereolus* var. *acicularis* (Ach.) Tuck. *No. 13*, Cañon City, Dyea Cr., Mar. 1898, fertile.

28. *Stereocaulon tomentosum* Fr. *No. 28.* Dawson, Oct. 1898, fertile.

29. *Stereocaulon tomentosum* var. *simplex* Riddle. *No. 84*, Dawson, May 24, 1899, fertile.

30. *Stereocaulon paschale* (L.) Ach. *No. 97*, Lake Lindeman, May 1898, fertile.

Family LECANORACEAE

31. *Pertusaria dactylina* (Ach.) Nyl. *No. 47*, Lake Lindeman, May 12, 1898, fertile.

32. *Pertusaria rhodocarpa* Koerb. *No. 77*, Sheep Camp, Dyea Cr., Apr. 1898, fertile.

33. *Lecanora lentigera* (Web.) Ach. *No. 64*, river bluffs just below Dawson, Apr. 13, 1899, fertile. *No. 87*, (?) *Lecanora crassa* (Schaer.) Dawson, Apr. 13, 1899, fertile, was considered by Tuckerman as identical with this species.

34. *Lecanora thamnoplaca* Tuck. *No. 51*, Dawson, Apr. 1899, fertile.

35. *Lecanora pallida* (Schreb.) Schaer. *No. 63a*, Lake Lindeman, May 1898, and *no. 99*, Sheep Camp, Dyea Cr., Apr. 1898, both fertile.

36. *Lecanora subfusca* var. *argentata* Ach. *No. 51*, Dawson, Apr. 1899.

37. *Lecanora subfusca* var. *campestris* Schaer. *No. 29*, 20 miles above Dawson on the Yukon, June 20, 1898, and *no. 57*, Dawson, Apr. 1899, both fertile.

38. *Lecanora rugosa* Nyl. *No. 89*, Dawson, Apr. 1899, fertile. This species was included by Tuckerman under the var. *allophana* Ach. of the preceding species.

39. *Lecanora epibrya* Nyl. *No. 30*, Dawson, July 1898, fertile. This species was included by Tuckerman under the var. *hypnorum* Schaer. of *subfusca*.

40. *Lecanora castanea* (Hepp) Th. Fr. *No. 88*, Dawson, Mar. 27, 1899, fertile.

41. *Lecanora ventosa* (L.) Ach. *No. 58*, Lake Lindeman, May 1898, fertile.

42. *Lecanora calcarea* (L.) Sommf. *No. 56*, Lower Klondike River, Apr. 1899, fertile.

43. *Lecanora* (*Acarospora*) *Schleicheri* (Ach.) Nyl. *No. 65*, river bluff just below Dawson, Apr. 23, 1899, fertile.

44. *Placodium* (*Candelariella*) *vitellinum*. (Ehrh.) Naeg. & Hepp. *No. 83*, Dawson, May 1899, fertile.

45. *Placodium ferrugineum* (Huds.) Hepp. *No. 96*, Dawson, Sept. 1898, fertile. Determined by Dr. Riddle. *No. 27*, Dawson, on willows, Sept. 1898, fertile, determined by Dr. Hasse as the synonymous *Blastenia ferruginea* (Huds.) Arn.

46. *Placodium Jungermanniae* (Vahl) Tuck. *No. 26*, Dawson, Sept. 1898, fertile.

47. *Placodium* (*Caloplaca*) *elegans* (Link) DC. *No. 25*, Dawson, Oct. 1898, fertile.

48. *Urceolaria* (*Diploschistes*) *scruposa* (L.) Nyl. *No. 23*, Moosehide Mt., back of Dawson, Apr. 2, 1899, fertile.

49. *Thelotrema lepadinum* Ach. *No. 60*, Sheep Camp, Dyea Cr., Apr. 1898.

Family COLLEMACEAE

50. *Collema melaenum* Ach. *No. 94* (2 packets), Klondike River, Mar. 18, 1899, *no. 44*, Lower Klondike, Sept. 18, 1898, both fertile.

51. *Collema melaenum* var. *polycarpum* Schaer. *No. 46*, Dawson, Apr. 3, 1899, fertile.

52. *Leptogium myochroum* var. *saturninum* (Schaer.) Tuck. *No. 45*, Dawson, Apr. 3, 1899, sterile.

53. (?) *Ephebe pubescens* Fr. *No. 91*, Dawson, July 1898, fertile. "Appears partially carbonized by fire."—Hasse.

Family PANNARIACEAE

54. *Pannaria (Parmeliella) lepidiota* var. *coralliphora* Tuck. *No. 33*, Dawson, common, Oct. 1898, fertile.
55. *Pannaria (Parmeliella) brunnea* (Sw.) Mass. *No. 21*, Cañon City, Dyea Cr., Mar. 27, 1898, fertile. "*Pannaria pezizoides* (Web.) Lightf."—Hasse.

Family PELTIGERACEAE

56. *Solorina saccata* var. *spongiosa* (Sm.) Nyl. *No. 35*, Dawson, Aug. 1898, fertile; *no. 22*, Lake Lindeman, May 1898, fertile.
57. *Solorina crocea* (L.) Ach. *No. 36*, Lake Lindeman, May 1898, fertile.
58. *Nephroma arcticum* (L.) Fr. *No. 20*, Lower Klondike, May 1899, sterile; Lake Lindeman, May 1898, fertile.
59. *Nephroma expallidum* Nyl. *No. 19*, Dawson, on rock, Apr. 6, 1899, fertile.
60. *Sticta (Lobaria) pulmonaria* var. *linita* (Ach.) Nyl. *No. 31*, Skagway, Lynn Canal, fertile.

Family UMBILICARIACEAE

61. *Umbilicaria (Gyrophora) Muhlenbergii* var. *alpina* Tuck. *No. 42*, Lake Lindeman, May 15, 1898, fertile.
62. *Umbilicaria (Gyrophora) hyperborea* Hoffm. *No. 43*, Lake Lindeman, May 8, 1898, fertile.
63. *Umbilicaria pustulata* (L.) Hoffm. *No. 41*, Dawson, Apr. 3, 1899, fertile.

Family PARMELIACEAE

64. *Parmelia conspersa* (Ehrh.) Ach. *No. 38*, Lake Lindeman, May 1898, fertile.
65. *Parmelia stygia* (L.) Ach. *No. 37*, Lake Lindeman, May 1898, sterile.

Family USNEACEAE

66. *Alectoria divergens* (Ach.) Nyl. *No. 68*, near Dawson, Apr. 2, 1899, sterile.
67. *Alectoria bicolor* (Ehrh.) Nyl. *No. 69*, Crater Lake, near Chilcoot Pass, May 24, 1898, sterile.
68. *Alectoria jubata* var. *implexa* (Hoffm.) Ach. *No. 71*, Dawson, on trees, Oct. 2, 1898, sterile.

69. *Alectoria ochroleuca* (Ehrh.) Nyl. *No. 67*, near Dawson, over rocks on top of Moosehide Mt., Apr. 2, 1899, sterile.
70. *Alectoria sarmentosa* Ach. *No. 78*, Sheep Camp, near Chilcoot Pass, Apr. 6, 1898, sterile.
71. *Usnea plicata* (L.) Web. *No. 73*, Dawson, on trees, Oct. 2, 1898, sterile. There is also a specimen of this species in the U. S. National Herbarium, collected in the Yukon, July 28, 1889, by I. C. Russell.
72. *Evernia prunastri* var. *thamnodes* Flot. *No. 72*, hills above Dawson, on birch, Mar. 18, 1899, fertile.
73. *Cetraria Oakesiana* Tuck. *No. 17*, Lake Lindeman, Apr. 24, 1898, fertile. This plant represents a new variety, a name for which is about to be published. Reference will be made to this record at the time of publication.
74. *Cetraria juniperina* var. *pinastri* Ach. *No. 14*, Dawson, common, sterile, Oct. 2, 1898; *no. 66*, on slide rock just back of Dawson, Apr. 23, 1899, sterile, with dark spermogones.
75. *Cetraria nivalis* (L.) Ach. *No. 18a*, Lake Lindeman, May 8, 1898, sterile.
76. *Cetraria cucullata* (Bell.) Ach. *No. 18b*, Dawson, Apr. 8, 1899, sterile; *no. 18*, Lower Klondike, May 14, 1899, fertile.
77. *Cetraria islandica* (L.) Ach. *No. 15*, Dawson, Apr. 2, 1899, fertile. The peculiarity of material from this region has been remarked upon by Miss Cummings. The present material, though suggesting the variety *crispa* Ach., is decidedly nearer the species and only suggests a slightly transitional condition.
78. *Cetraria Richardsonii* Hook. *No. 74*, Summit of Moosehide Mt., near Dawson, May 1899, fertile.
79. *Cetraria* (*Dactylina*) *arctica* (Hook.) Tuck. *No. 95*, above Lake Lindeman, common, May 1898, sterile.
80. *Ramalina pusilla* Prév. *No. 40*, Dawson, on dead spruce, Mar. 1899, fertile. (= *R. minuscula* Nyl.)
81. *Ramalina polymorpha* Ach. *No. 39*, Dawson, on slide rock, Apr. 1899, sterile.

The collection contains three specimens that are indeterminable.

No. 6, a *Cladonia* "too fragmentary for certain determination." —Riddle.

No. 82, an *Acarospora* "no spores."—Hasse.

No. 49, a *Lecidea*, probably belonging to the *L. arctica* Sommf. group of the *L. alpestris* stock, "differing from that probably in the brown color of the thallus granules."—Riddle.

I have followed the order and classification of Miss C. E. Cummings' Lichens of Alaska for convenience of comparison. The species numbered in black faced type were not included in the body of that work, though sometimes listed under "Additional Species."

THOREAU MUSEUM OF NATURAL HISTORY,
CONCORD, MASS.

Notes on Rutaceae—V. Species characters in Ptelea and Taravalia

Percy Wilson

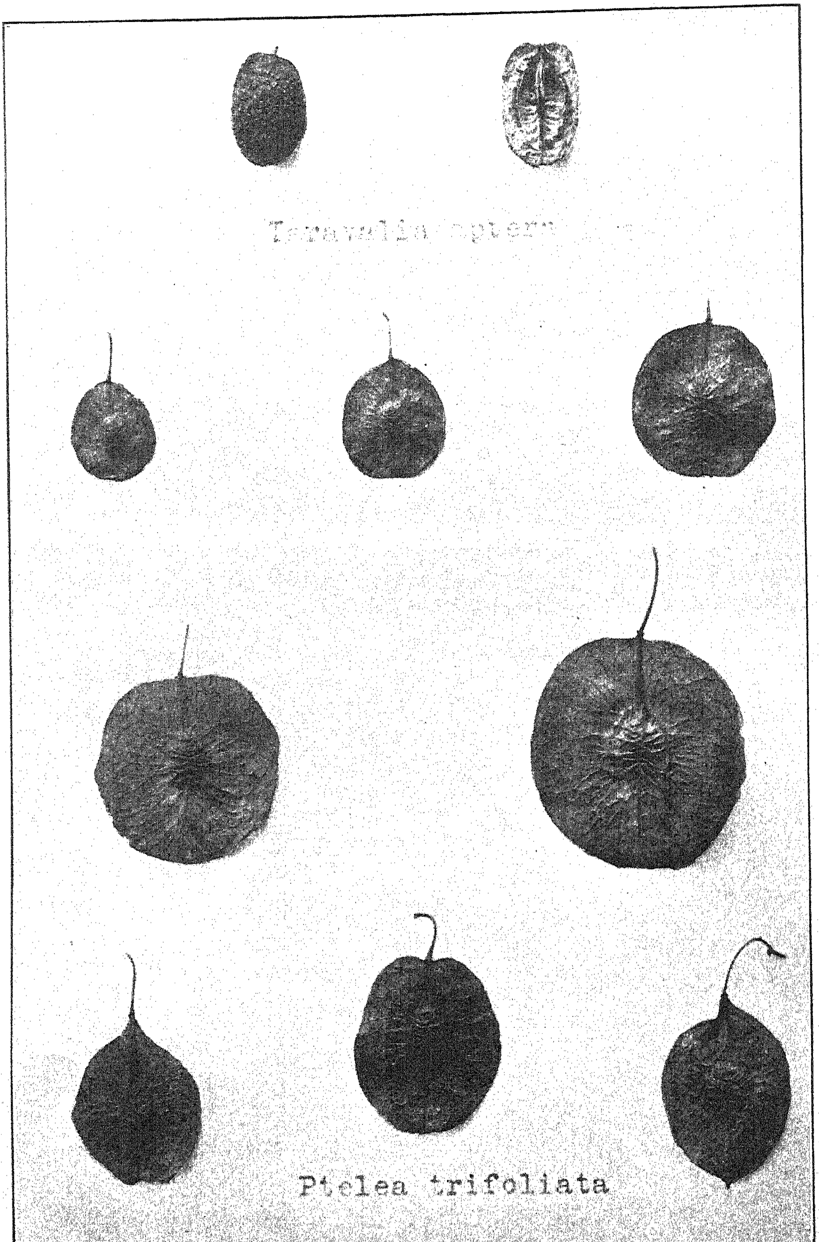
The genus *Ptelea* as understood by Linnaeus, 1753, comprised two species, *P. trifoliata* L. from Virginia, and *P. viscosa* L. from India. The second species, was, however, later referred to *Dodonaea*, a genus of the Sapindaceae which has samaroid fruits resembling those of *Ptelea*.

In the recent issue of the North American Flora, three species of *Ptelea* are recognized, two of which are regarded by some authors as varieties of *P. trifoliata* L. The characters used to separate these species cannot always be depended upon as there are various intermediate forms.

A large number of specimens of *Ptelea* have been examined in various herbaria, including types or cotypes of nearly all the published species, and an excellent opportunity for a comparative study of living plants of *P. trifoliata* L. has been afforded at the New York Botanical Garden, where many individuals of this species are under cultivation. These show great variation in their leaflets, color of bark, and form and size of the samaras, which vary from obovate to elliptic or suborbicular and are one to three centimeters in diameter. (See FIGURE.) The flowers are essentially alike except in size. Although the number of petals has sometimes been used as a character for distinguishing species, it is not uncommon to find flowers with both four and five petals in the same species, and often on the same branches.

Ptelea Baldwinii T. & G. is represented in the Torrey herbarium by a small specimen collected by Baldwin at "St. Johns, E. Florida," and *P. angustifolia* Benth. is illustrated by a drawing and fragments from the type. While there is a slight difference in the form of their leaflets, the specimens undoubtedly represent one species.

Of the large number of species and varieties of *Ptelea* which have been described within the past few years, by several authors, in the majority of cases from single specimens examined, some



Fruit variations in *Ptelea* and *Taravalia.*

are identical with type material of one or the other of the above, while others are apparently mere leaf variations of these, or of *P. tomentosa* Raf. (of which *P. trifoliata mollis* T. & G. appears to be a form), or of *P. trifoliata* L.

Taravalia Greene, endemic in Lower California, has tardily dehiscent, tough, nutlike, woody capsules, which are more or less distinctly margined, and very unlike the winged samaras of *Ptelea*. Although three species of *Taravalia* have been described, I have failed to find characters to admit more than one.

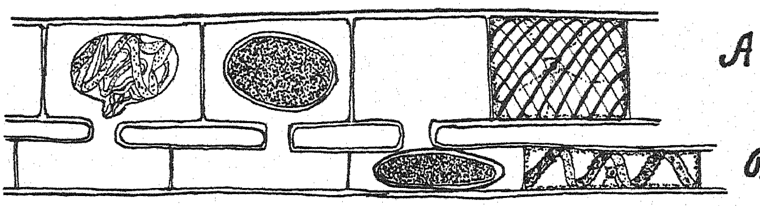
NEW YORK BOTANICAL GARDEN.

Conjugation of two different species of Spirogyra

F. M. ANDREWS

Instances of irregularity in the behavior and conjugation of *Spirogyra* have been observed from time to time by botanists. In some of these cases two different species have been seen conjugating, of which the following is an example.

A large quantity of the two species here shown was found in September in a pond, and all stages in the process of conjugation could be seen. Most of the same kind were conjugating together. In a good many cases, however, the two different species, as shown in the accompanying figure, were to be seen conjugating. In the figure the larger specimen, *A*, is *Spirogyra crassa* and the smaller one, *B*, is *Spirogyra communis*. Some of these two different species which were not in a state of conjugation did conjugate when brought into the laboratory and put under artificial conditions.



Conjugation of *Spirogyra crassa*, *A*, and *S. communis*, *B*.

In most cases the contents of the cells of the smaller species, *Spirogyra communis*, passed over to the larger one, *Spirogyra crassa*, in the process of conjugation. This, however, was not by any means always the case, since instances were found, as shown by the accompanying figure, in which the contents passed from the cells of *Spirogyra crassa* to those of *Spirogyra communis*. Aside from a difference in size and form, the zygospores seemed perfectly normal.

There are interesting questions connected with the hybrid form that would arise from the conjugation of two different species of *Spirogyra*, and investigations are in progress to determine these points.

INDIANA UNIVERSITY,
BLOOMINGTON, IND.

INDEX TO AMERICAN BOTANICAL LITERATURE

19 8–11)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers, at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

Arechavaleta, J. Vegetación Uruguaya. An. Mus. Nac. Montevideo. II. **1**: 59–83. *f. 1–6.* 1911.
Includes descriptions of 19 new species.

Bartlett, H. H. *Ptelea mollis* var. *cryptoneura*, a wafer-ash of the Georgia sand-hills. Rhodora **13**: 80–82. 1 My 1911.

Benedict, R. C. The genera of the fern tribe *Vittarieae*: their external morphology, venation, and relationships. Bull. Torrey Club **38**: 153–190. *pl. 2–8.* 5 My 1911.
Includes *Polytaenium quadriseriatum* Benedict sp. nov. and the new subgenus *Radiovittaria.*

Benedict, R. C. A new *Antrophyum* from Luzon. Am. Fern Jour. **1**: 71–74. *pl. 4.* 3 My 1911.
Antrophyum Williamsi Benedict sp. nov.

Berger, A. *Furcraea longaeva* Zucc. und *F. Bedinghausii* C. Koch. Monats. Kakteenk. **21**: 41–43. 15 Mr 1911.

Bessey, C. E. On the preparation of botanical teachers. Science II. **33**: 633–639. 28 Ap 1911.

Blewitt, A. E. Some introduced plants of Connecticut. Rhodora **13**: 88–90. 1 My 1911.

Börgesen, F. Some new or little known West Indian *Florideae*. II. Bot. Tidssk. **30**: 177–207. *f. 1–20.* 9 D 1910.

Includes the new genus *Coelarthrum* and new species in *Chantransia* (1) and in *Chrysymenia* (1).

Brainerd, E. The caulescent violets of the southeastern United States. Bull. Torrey Club **38**: 191–198. 5 My 1911.

Brainerd, E. New stations for *Dryopteris Goldiana*×*marginalis* in Vermont. Am. Fern Jour. **1**: 78, 79. 3 My 1911.

Britton, E. G. Fern collecting in Cuba. Am. Fern Jour. **1**: 75–77. 3 My 1911.

Brown, N. E. *Elaeagnus argentea.* Curt. Bot. Mag. IV. **7**: *pl. 8369.* Ap 1911.

Caldwell, O. W. The product of our botanical teaching. Science II. **33**: 639–642. 28 Ap 1911.

Candolle, C. de. *Piperaceae.* [In F. Pax: Plantae novae bolivianae. V.] Repert. Sp. Nov. **9**: 229–235. 5 Mr 1911.

Describes 11 new species in *Piper.*

Cavers, F. The inter-relationships of the *Bryophyta.* New Phytol. **9**: 81–112. *f. 1–17.* 28 Ap 1910; **9**: 157–186. *f. 18–29.* My 1910; **9**: 193–234. *f. 30–43.* 6 Au 1910; **9**: 269–304. *f. 44–54.* 25 N 1910; **9**: 341–353. 30 D 1910; **10**: 1–46. *f. 55–72.* 13 Mr 1911; **10**: 84–86. 31 Mr 1911.

Christensen, C. The *Pteridophyta* of the arctic regions. Am. Fern Jour. **1**: 65–70. 3 My 1911.

Clements, F. E. Methods of botanical teaching. Science II. **33**: 642–646. 28 Ap 1911.

Clute, W. N. Another form of *Dicksonia.* Fern Bull. **19**: 7, 8. [Ap] 1911. [Illust.]

Dicksonia pilosiuscula f. *Poyseri.*

Clute, W. N. *Asplenium Andrewsii.* Fern Bull. **19**: 3, 4. [Ap] 1911. [Illust.]

[Clute, W. N.] Rare forms of fernworts—XVII. *Botrychium simplex.* Fern Bull. **19**: 11–14. [Ap] 1911. [Illust.]

Copeland, E. B. Physiology of the coconut. Philip. Agric. and Forester **1**: 44–50. Mr 1911.

Coulter, J. M. [Botanical teaching:] Discussion. Science II. **33**: 646. 28 Ap 1911.

Cousins, H. H. The banana and its culture in Jamaica. Bull. Dept. Agric. Jamaica **1**: 217–235. *pl. 61–63.* Mr 1911.

Coville, F. V. The use of acid soil for raising seedlings of the mayflower, *Epigaea repens*. Science II. **33**: 711, 712. 5 My 1911.

Dachnowski, A. The ancient vegetation of Ohio and its ecological conditions for growth. Ohio Nat. **11**: 312–331. 3 Ap 1911.

Detmers, F. The vascular plants of the cranberry bog in Buckeye Lake. Ohio Nat. **11**: 305, 306. 3 Ap 1911.

Dietel, P. Einige Bemerkungen zur geographischen Verbreitung der Arten aus den Gattungen *Uromyces* und *Puccinia*. Ann. Myc. **9**: 160–165. Mr 1911.

Eastwood, A. Hartweg's explorations in California—III. Muhlenbergia **7**: 37–43. 27 Ap 1911;—IV. Muhlenbergia **7**: 49, 50. 15 My 1911.

Edwards, S. C. Notes on the gray polypody. Am. Fern Jour. **1**: 83. 3 My 1911.

Eichlam, F. Mitteilungen aus Zentral-Amerika—VII. Monats. Kakteenk. **21**: 17–22. 15 F 1911;—VIII. Monats. Kakteenk. **21**: 33–41. 15 Mr 1911. [Illust.]

Fairman, C. E. Fungi Lyndonvillenses novi vel minus cogniti. Series II. Ann. Myc. **9**: 147–152. *f. 1–7.* Mr 1911.

Includes descriptions of 8 new species in *Phoma* (3), *Cladosporium* (1), *Volutella* (1), *Ophiobolus* (1), *Mollisia* (1), and *Phialea* (1).

Ferdinandsen, C., & Winge, Ö. Fungi from Prof. Warming's expedition to Venezuela and the West-Indies. Bot. Tidssk. **30**: 208–222. *f. 1–7.* 9 D 1910.

Includes the new genera *Myxotheca* and *Stilbochalara* and new species in *Helotium* (1), *Myxotheca* (1), *Sterigmatocystis* (1), and *Stilbochalara* (1).

Flynn, N. F. Flora of Burlington and vicinity. A list of the fern and seed plants growing without cultivation. vii–ix+1–124. 1911.

Fobe, F. Für die Kultur empfehlenswerte *Echinocereus*-Arten. Monats. Kakteenk. **21**: 43–45. 15 Mr 1911; **21**: 54–59. 15 Ap 1911.

Fries, R. E. Eine neue *Wissadula*-Art aus Paraguay. Repert. Sp. Nov. **9**: 211. 5 Mr 1911

Wissadula indivisa R. E. Fries.

Gates, R. R. Studies on the variability and heritability of pigmentation in *Oenothera*. Zeits. Induk. Abstammungs- und Vererbungslehre **4**: 337–372. *pl. 6+f. 1–5.* Mr 1911.

Gloyer, W. O. The occurrence of apple blotch in Ohio. Ohio Nat. **11**: 334–336. *f. 1–4.* 3 Ap 1911.

Greene, F. C. The ferns of northwestern Missouri. Fern Bull. **19**: 14, 15. [Ap] 1911.

Griffon, E. Observations et recherches expérimentales sur la variation chez le maïs. Bull. Soc. Bot. France **57**: 604–615. 24 F 1911.

Guyer, M. F. Nucleus and cytoplasm in heredity. Am. Nat. **45**: 284–305. My 1911.

Hall, J. G., & Massey, A. B. Plants in flower February 8, 1911, at Clemson College, South Carolina. Rhodora **13**: 91, 92. 1 My 1911.

Harper, R. M. *Chondrophora virgata* in west Florida. Torreya **11**: 92–98. *f. 1.* 19 Ap 1911.

Harvey, J. C. Notes on *Laelia rubescens*. Orchid Rev. **19**: 71, 72. *f. 6.* Mr 1911.

Hassler, E. *Convolvulaceae*—I. [In Ex herbario Hassleriano: Novitates paraguarienses. XII.] Repert. Sp. Nov. **9**: 148–160. 10 F 1911; [In Ex herbario Hassleriano: Novitates paraguarienses. XIII.] Repert. Sp. Nov. **9**: 193–197. 5 Mr 1911.

Herre, A. W. C. T. The desert lichens of Reno, Nevada. Bot. Gaz. **51**: 286–297. 17 Ap 1911.

Includes *Lecidea Truckeei* Herre and *Endocarpon tortuosum* Herre spp. nov.

Hickel, R. Graines et plantules des conifères. Bull. Soc. Dendr. France **19**: 13–115. *f. 1–53.* 15 F 1911.

Hill, E. J. *Lycopodium porophilum* in the Dells of the Wisconsin. Fern Bull. **19**: 1–3. [Ap] 1911.

Hitchcock, A. S. Additions to the grasses of Cuba. Bot. Gaz. **51**: 300–302. 17 Ap 1911.

Includes *Paspalum Leoninum* Chase sp. nov.

Hollick, A. The paleobotanical collections of the New York Botanical Garden. Proc. Am. Assoc. Mus. **4**: 43–52. My 1911.

Kirk, G. L. *Glyceria acutiflora* in Vermont. Rhodora **13**: 92. 1 My 1911.

Klugh, A. B. Notes on the *Pteridophyta* of southern New Brunswick. Fern Bull. **19**: 4–7. [Ap] 1911.

Knowlton, C. H., *and others.* Report on the flora of the Boston district—X. Rhodora **13**: 82–85. 1 My 1911.

Lovejoy, A. O. The meaning of vitalism. Science II. **33**: 610–614. 21 Ap 1911.

MacDougal, D. T. Alterations in heredity induced by ovarial treatments. Bot. Gaz. **51**: 241–257. *pl. 14–16* + *f. 1–3.* 17 Ap 1911.

Mell, C. D. Purple basket willow. Am. Forestry **17**: 280–287. My 1911. [Illust.]

Salix purpurea L. and varieties.

Moxley, G. L. Some Southern California ferns. Am. Fern Jour. **1**: 82. 3 My 1911.

Neger, F. W. Ambrosiapilze—IV. Tropische Ambrosiapilze. Ber. Deuts. Bot. Gesells. **29**: 50–58. 30 Mr 1911.

Newcombe, F. C. [Botanical teaching:] Discussion. Science II. **33**: 646–649. 28 Ap 1911.

Niedenzu, F. De genere *Màscàgnià*. Arb. Bot. Inst. Kgl. Lyc. Hosianum in Braunsberg **3**: 1–29. 1908.

Diagnoses of the new species are reprinted in Repert. Sp. Nov. **9**: 267–273. 1 Ap 1911.

Osterhout, G. E. *Senecio lanatifolius* Osterhout. Muhlenbergia **7**: 47, 48. 27 Ap 1911.

Pardé, L. Enquête sur l'acclimatation des essences exotiques en France. Bull. Soc. Dendr. France **19**: 5–12. 15 F 1911. [Illust.]

Pax, F. Plantae novae bolivianae—V. Repert. Sp. Nov. **9**: 229–235. 5 Mr 1911.

Includes *Piperaceae* by C. de Candolle.

Prescott, A. The oak and beech ferns. Fern Bull. **19**: 9–11. [Ap] 1911.

Pring, G. H. Orchids of the Missouri Botanic Garden. Orchid Rev. **18**: 141–143. My 1910.

Purpus, J. A. *Mamillaria Sartorii* J. A. Purpus sp. nov. Monats. Kakteenk. **21**: 50–53. 15 Ap 1911. [Illust.]

Rick, J. *Fungi* austro-americani fasc. XI–XVIII. Ann. Myc. **9**: 175–184. Mr 1911.

[Rolfe, R. A.] Brasilian orchids. Orchid Rev. **18**: 327, 328. N 1910.

[Rolfe, R. A.] *Cattleya Warscewiczii alba*. Orchid Rev. **18**: 232, 233. *f. 14*. Au 1910.

Rolfe, R. A. *Trevoria Lehmanni*. Orchid Rev. **18**: 297–299. *f. 18*. O 1910.

Rose, J. N. *Burseraceae*. N. Am. Fl. **25**: 241–261. 6 My 1911.

Includes descriptions of the following new species: *Elaphrium epinnatum, E. occidentale, E. Covillei, E. confusum, E. brachypodum, E. longipedunculatum, E. queretarense, E. Goldmani, Icica fragrans, I. sessiliflora, I. glabra, I. costaricensis, I. confusa, I. Pittieri, I. lucida, I. Palmeri, I. panamensis,* and *I. attenuata*.

Rose, J. N. Studies of Mexican and Central American plants—No. 7.

Contr. U. S. Nat. Herb. **13**: 291–312+ix, x. *pl. 46–67* + *f. 55*. 11 Ap 1911.

Includes 2 new genera, *Graptopetalum* and *Erioxylum*, and many new species.

Schlechter, R. *Orchidaceae* novae et criticae. XIX. Repert. Sp. Nov. **9**: 212–218. 5 Mr 1911.

Includes *Pleurothallis Wercklei, Epidendrum anoglossum, E. cardiophorum, E. Schumannianum,* and *Ornithidium bracteatum* spp. nov. from Costa Rica.

Schlechter, R. *Orchidaceae* novae et criticae. XX. Repert. Sp. Nov. **9**: 281–287. 1 Ap 1911.

Stelis Bourgeavii Schlechter described from Mexico.

Schreiner, O., & Sullivan, M. X. Concurrent oxidation and reduction by roots. Bot. Gaz. **51**: 273–285. 17 Ap 1911.

Scudder, H. Similarity of color in bud and in leaf. Rhodora **13**: 86, 87. 1 My 1911.

Sinnott, E. W. Some features of the anatomy of the foliar bundle. Bot. Gaz. **51**: 258–272. *pl. 17*. 17 Ap 1911.

Small, J. K. *Simaroubaceae*. N. Am. Fl. **25**: 227–239. 6 My 1911.

Includes *Castelaria* gen. nov., and *Castelaria jacquiniifolia* and *C. Brittonii* spp. nov.

Smith, E. F., Brown, N. A., & Townsend, C. O. Crown-gall of plants: its cause and remedy. U. S. Dept. Agric. Bur. Pl. Ind. Bull. 213: 1–215. *pl. 1–36*. 28 F 1911.

Standley, P. C., & Blumer, J. C. A new *Castilleja* from the southern Rocky Mountains. Muhlenbergia **7**: 44–47. *pl. 5* + *f. 7*. 27 Ap 1911.

Castilleja austromontana Standley & Blumer sp. nov.

Sterner, O. Mitteilungen über Blütenansatz einiger Phyllokakteen aus meinen Kulturen im Jahre 1910. Monats. Kakteenk. **21**: 59–62. 15 Ap 1911.

Stevens, F. L. Progress in control of plant diseases. Pop. Sci. Mo. **78**: 469–476. *f. 1–4*. My 1911. [Illust.]

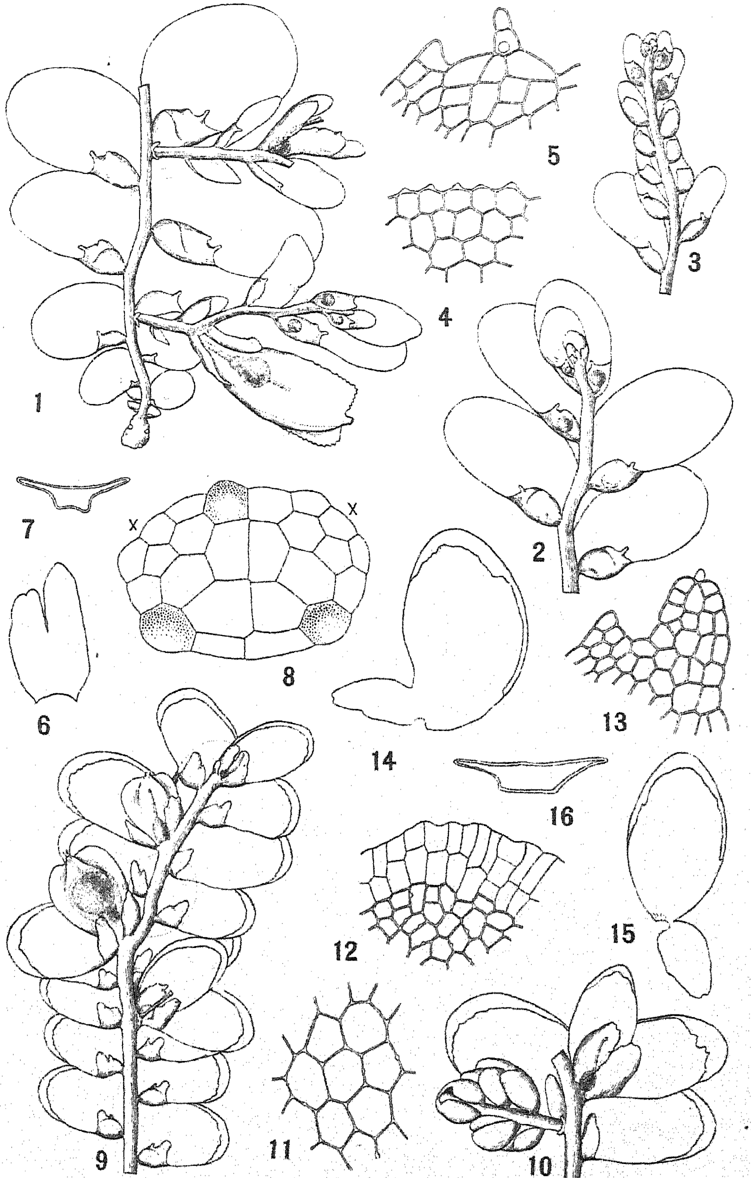
Swartz, M. D. Nutrition investigations on the carbohydrates of lichens, algae, and related substances. Trans. Conn. Acad. **16**: 247–382. *f. 1, 2*. Ap 1911.

Thompson, E. J. Botanizing in central Connecticut. Rhodora **13**: 77–79. 1 My 1911.

Wilson, P. *Rutaceae*. N. Am. Fl. **25**: 173–224. 6 My 1911.

Includes descriptions of the following new species: *Ravenia simplicifolia, Zanthoxylum Shaferi, Z. Kellermanii, Z. Goldmani, Amyris stromatophylla,* and *Spathelia Brittonii*.

Wilson, P. *Surianaceae*. N. Am. Fl. **25**: 225. 6 My 1911.



1—8 LEPTOCOLEA SCABRIFLORA (Gottsche) Evans

9—16 LEPTOCOLEA PLANIFOLIA Evans

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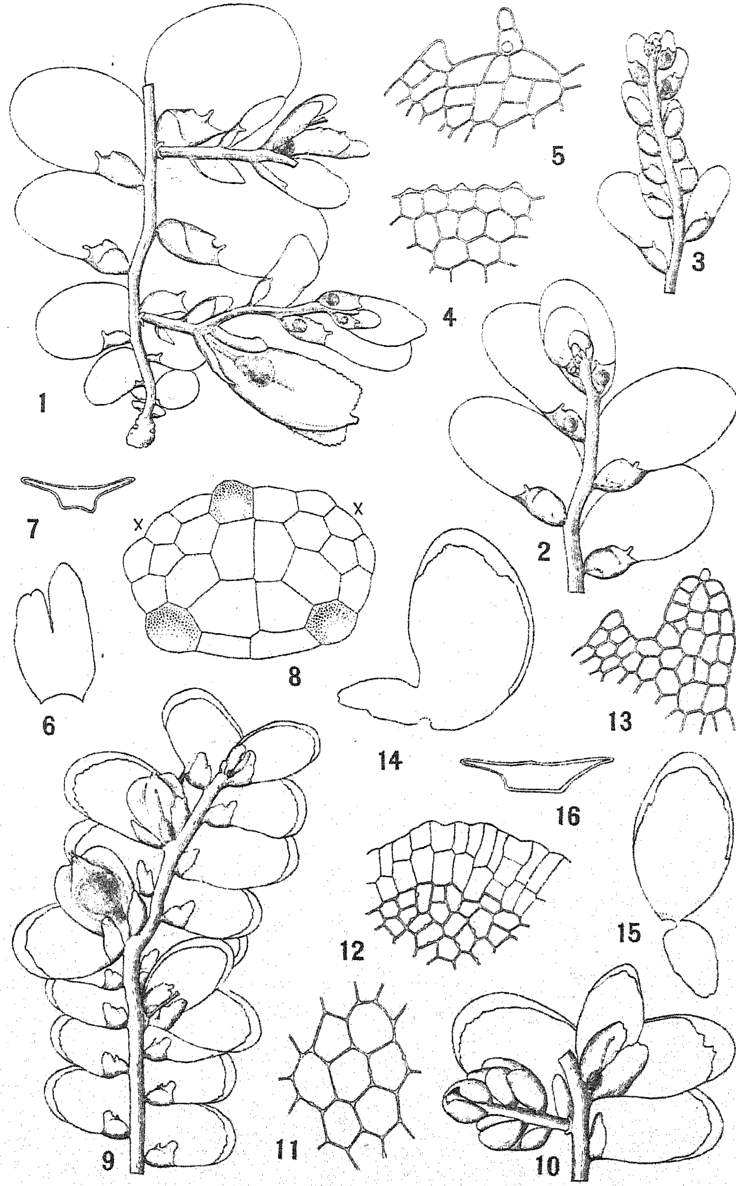
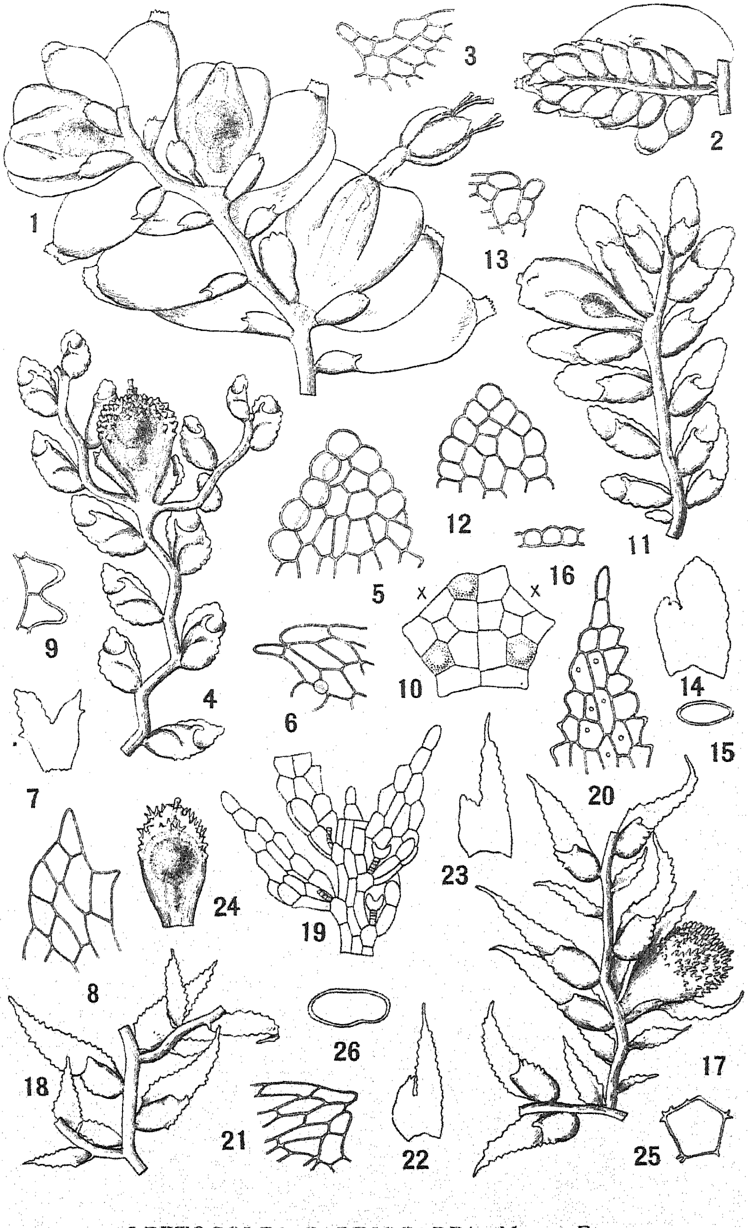


1—8 LEPTOCOLEA SCABRIFLORA (Gottsche) Evans

9—16 LEPTOCOLEA PLANIFOLIA Evans



1–3 LEPTOCOLEA CARDIOCARPA (Mont.) Evans
4—10 APHANOLEJEUNEA EXIGUA Evans
11—16 APHANOLEJEUNEA CRENATA Evans

Vol. 38 No. 7

BULLETIN

OF THE

TORREY BOTANICAL CLUB

JULY, 1911

On the anomalous splitting of the rhizome and root of Delphinium scaposum

Margaret Appleton Kingsley

(with plates 13 and 14)

Delphinium scaposum, first named by Greene,* is one of the xerophytic forms of the Ranunculaceae. The material used in this investigation was collected at the Desert Laboratory at Tucson, Arizona, under the kind direction of Dr. D. T. MacDougal of the Carnegie Institution. It was carefully killed at that time, and proved most satisfactory for anatomical study.

As to its distribution, Huth,† who names it *Delphinium decorum β scaposum* (Greene) Huth, reports that it was mentioned by Parry, 1874, as found in southern Utah, and by Pringle, 1883, in the Arizona hills near Tucson, the same territory from which this material was sent. Greene records its presence in the hill country between the Gila and San Francisco rivers, May 25, 1880, and says that Dr. Asa Gray informed him that Professor Newberry obtained what appeared to be the same, south of the Diamond River in Arizona.* In this same account, Greene gives the only adequate description of the plant, which I quote in part, as I have no acquaintance with the living form. "Leaves all radical, rather fleshy, pubescent, 3-parted, the divisions broadly cuneate, 3–5-cleft or toothed, the teeth ending in a callous point, racemose at summit, pedicels as long as the deep azure flowers; spur incurved, root a

*E. L. Greene. New Species of Plants from New Mexico. Bot. Gaz. 6: 156–158. 1881.

†Ernst Huth. Die Delphinium-Arten der Vereinigten Staaten von Nord-Amerika. Abhand. und Vorträge Gesammtgeb. Naturw. 4^3: 9. 1892.

[The Bulletin for June 1911 (38: 251–306. *pl. 11, 12*) was issued 6 Jl 1911.]

cluster of thickened fleshy fibres. . . . An interesting species as combining the leafless stem of the scarlet flowered Californian *D. rudicaula* with the deep blue flowers of *D. azureum*."

The aerial part consists of leaves whose long pétioles arise spirally from a restricted underground shoot, and blossoms borne on long stalks. These flourish in the brief rainy season and then die back, and the next year's leaves and flowers originate from a terminal bud, or from buds found one in the axil of each foliage leaf. The perennial part of the plant is subterranean, and is of the nature of a rhizome with roots attached. This is the part that was particularly studied here.

On examination of this portion of the plant body, of several different specimens, the most apparent characteristic common to all is the splitting up into separate members of the rhizome and root (FIG. 1). There is no regularity about the number or arrangement of the resulting columns, nor is their origin as separate individuals at an equal distance from the base of the annual shoot. In one case a specimen will appear like a miniature tree trunk covered with a dark brown barklike formation which easily crumbles off. This trunk continues down as one united column for an inch, and then abruptly divides into two unequal parts. If a cross section of the main trunk were examined immediately before this separation (FIG. 2) it would show a peripheral circle made up of single columns (in cross section), the central space and divisions between which are filled with this same loose brown necrotic tissue that surrounds the outside. Shallow grooves can be distinguished running longitudinally along the trunk, and continuing more deeply cleft in each of the two divisions, so that the first consists apparently of four, the second of seven united columns.

Following these two divisions down a short distance, we find them resolving themselves into their component members, or groups of two or three, and separating from each other. Each of these ultimate branches may continue as it is, or may later divide after it has attained a certain secondary growth in thickness. Occasionally a splitting apart occurs for a short distance and is followed by a complete union of these same members into one strand, which leads to the just conclusion that the phenomenon is one of splitting of mature organs rather than a peculiarity in

Fig 1.

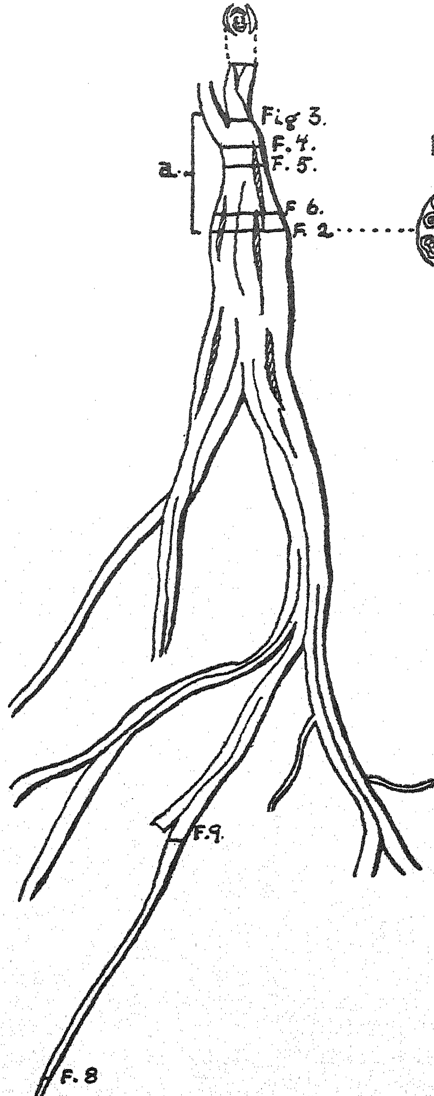


Fig. 2.

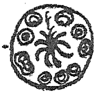


FIG. 1. Rhizome and root (natural size), showing where successive cross sections are taken.

FIG. 2. Cross section as indicated on FIG. 1, showing origin of separate columns. Necrotic central region.

regular growth development. Consequently, the whole appearance of the underground part of *Delphinium scaposum* is that of a highly complicated "cluster of fleshy roots" in part of their extent bound together like a cable, in part ramifying about irregularly through the soil and thus obtaining a wide spread. In another specimen, splittings occur almost immediately below the annual shoot. These split-off pillars need not necessarily be circular in cross section, for as often columns are found sickleform in cross section. (Later examination reveals the fact that whereas the circular sections contain but a single vascular bundle and its secondary thickenings, the sickleform ones invariably have two or more distinct primary bundles with the rays between.) These practically always divide ultimately into members assuming this same circular appearance.

Since there is no set order followed that can be discovered from external characteristics, the phenomenon of this splitting must be investigated internally. The only available matter published on this subject is a series of articles by Jost appearing in the Botanische Zeitung, 1890, and all references to the various forms he investigated will be referred to by page without repeating the entire reference each time after the first. My most satisfactory work was done with free-hand sections, treated with KOH and mounted in glycerine. Though some successful imbedding in paraffin was accomplished through the carbon disulphid process, the stained slides were more difficult to elucidate than the others, and proved of less value for actual study.

If we take a specimen like FIG. 1*a*, which shows, natural size, a piece of the rhizome and the leaf bases of the aerial shoot, and examine successive cross sections, we shall be able to trace this separation from the individual main stem of the aerial shoot down to the complete circle of separate columns, as shown in FIG. 2. The places where all successive sections described in this series are cut, are indicated on FIG. 1. The first section (PLATE 13, FIG. 3) shows a regular primary stem structure. The hollow center is surrounded by four rows of parenchyma cells, outside of which is a circle of separate open collateral bundles. These primary bundles consist of xylem, cambium, phloem, with a heavy stereome cap, outside of which are five rows of cortical parenchyma cells, surrounded by a

single-layered epidermis. Jost mentions the fact that "the aerial stems of so many Ranunculaceae show only a slight growth in thickness and develop no interfascicular cambium."* Farther down we find a complete cambium ring, through the activity of which the radial length of the primary bundles has been increased, not so much in xylem and phloem elements as in parenchyma, 4–7 rows of which are found on each side of the cambium. This has pushed the stereome cap farther out in the cortex, and we also find a periderm beginning to form to replace the epidermis. The secondary thickening in this and later sections is formed by a cambium that produces one ring of elements annually. This is anomalous to some extent, since it forms much more parenchyma than sieve or xylem ducts. The reason for this fact cannot be absolutely proved, but there may be a water storage function for all these thin-walled cells, which a xerophyte might very readily utilize. The cambium (FIG. 4) next produces weak secondary xylem elements outside of the primary xylem (which is flanked on both sides by stereome), followed by about five rows of equilateral parenchyma cells and five rows of brickshaped cells. The general change in shape suggests the spring and fall cells in wood, and probably owes its existence to the same slowing down in growth at the end of the growing season.

Outside of the cambium much parenchyma and a few sieve cells have been produced. In the outer cells of this closely packed cortex, separating it from the loose, irregular peripheral cells, appears a single row of cells with slightly thickened lateral walls, which makes a complete circle of the stem and forms an endodermis. Some of the primary cortex with its masses of stereome has become broken up, probably due in part to growth pressure from within. There is a darkening of the pith around the hollow center, which indicates necrosis of the tissues. In the next lower section (FIG. 5), which shows three years growth in thickness, we find the parenchyma which surrounds the first year xylem assuming the irregular appearance of the cortical parenchyma. A circle of cells exactly similar to the endodermis has formed inside, cutting off from the rest of the wood the xylem of the original bundles, enclosing the

* Jost. Die Zerklüftungen einiger Rhizome und Wurzeln. Bot. Zeit. 48: 484. Jl 1890. (On *Aconitum Lycoctonum*.)

necrotic pith. Undulations appear in the outer endodermis, one of which develops into a deep cleftlike projection through the rays between the bundles and toward the center of the stem, from which the inner endodermis extends out to meet it. By the union of these the stem is divided on one side. This phemomenon may occur simultaneously in more than one radius, thus dividing the section into several parts. But in each case this method holds good, and in each case either one radial bundle mass is separated off into a circular column, or more are cut off into a sickleform group.

In his discussion of splitting in *Gentiana cruciata*,* Jost describes the division as being due to the separation of parts, by a row of newly originating cork-covered parenchyma cells, which he calls "periderm." This he considers to be a single layer of cells that have been separated off and become corky, not in any way to be considered phellogenetic in origin. The pith also is cut off by an inner periderm originating from a cork cambium, which pushes out into the wood parenchyma between the fusion bundles in order to meet this "cortical periderm." This "periderm" as described, exactly agrees with the "endodermis" found in *D. scaposum*.

Following the invasion of the central necrotic region by the endodermis, the parenchyma isolated between the two sides of the cleft dies and forms a continuous link between the necrotic areas from center to periphery. In response to the death of the tissue there is the formation of a cork layer similar to wound periderm, which protects the living tissues inside from the decaying surrounding tissues. Jost also corroborates this interpretation when he says, in speaking of *Gentiana cruciata* and *Corydalis nobilis*,† that the periderm is the consequence of necrosis of tissues, and the necrosis of tissues in both cases must have an inner cause. We find cork formation taking place on all sides of the split-off columns.

This cast-off periderm on the outside easily disappears in the earth. But in cases where we find a complete circle of columns still seemingly bound in one trunk (FIG. 2), the rotting central "bark" cannot be cast off and necessarily accumulates. This large mass of dead material can hardly be all attributed to cork forma-

* Jost. Loc. cit. p. 43.

† Jost. Loc. cit. p. 476.

tion, from the excessive amount and comparative protection of the parts thus clothed. Part of its bulk must of necessity arise from the necrotic parenchymatous pith and primary bundles cut off in the center. And careful examination of the dead elements found here, shows ducts, spiral and reticulate, as well as many fibrous pieces made up of stereome strands.

Jost believes that each old year's wood, as it becomes useless for water conduction or ceases to be in direct connection with the present year's annual growth, is cut off from the living functioning parts by this circular periderm formation, and dies, thus adding to the bulk of necrotic tissue and lessening the area of activity. Jost describes minutely this phenomenon in several cases. In *Gentiana cruciata,** as secondary growth continues, forming new wood and cortex, old tissues are constantly cut off by an ever originating parenchymatous periderm and the significance of this periderm is to separate the functionless wood and bast in the rhizome and root from the living. In *Corydalis Ochroleuca,*† only those bundles are kept that are in direct union with leaf parts. The rest die off, and jagged parenchyma strands in the wood, by turning brown and dying, form the splits. In *Aconitum Lycoctonum*‡ (as in *Gentiana*) under symmetrical cork formation about the living tissues, and with parenchyma cells cut off that become corky about dying tissues, never more than two years' growth is left active. Periderms formed later are either concentric with the first or contribute to further splitting as already described. In *Sedum,*§ old years are all cut off by the periderm, and only the one youngest ring remains active. In *Delphinium*, such wholesale destruction apparently does not exist. No necrosis, cutting off bundle elements, can be found before the second year, and in no older form is less than two years' growth active.

In a rhizome showing four years of xylem (FIG. 6) the primary xylem is disintegrated, in the center directly outside of the necrotic pith region, and is cut off from all the rest of the wood by heavy cork zones that have particularly strong inner rims, and surround each a different one of the five columns of the split rhizome. Each

*Jost. Loc. cit. pp. 444, 461.

†Jost. Loc. cit. p. 477.

‡Jost. Loc. cit. p. 490.

§Jost. Loc. cit. p. 504.

one of these columns (PLATE 14) directly inside of the cork layer, has a circular region of irregular, loose parenchyma (not disintegrated to the extent of becoming brown, however). In this loose tissue the secondary xylem elements can be seen separated out from the third and fourth year elements, all three of which are surrounded by a complete ring of endodermis. This endodermis marks the outer limit of the regular close cortex, and may become, as secondary wood and parenchyma are produced inside, so stretched out and pushed into outer cortex, that it becomes the seat of activity for the production of a new cork region as the disintegrating cortical cells invade this central portion farther.

This column (as shown in PLATE 14) is not perfectly rounded. But the presence of a very active meristematic zone inside of the former inner endodermis cutting off cells on the inner side, seems to account for the final rounding off of these separate members.

Owing to the necrosis of tissues in the center of older parts, it is impossible to determine with any degree of accuracy where rhizome ends and root begins. To follow out the root changes we must begin, as in the case of the stem, with the youngest parts. The lower end of one of the final divisions, in cross section, shows a diarch root arrangement (FIG. 8), with the axial strand small but developed apparently in centripetal order, since the larger ducts are in the center, the smaller toward the outside; also since longitudinal sections show the same order of duct formation—spiral toward the outside, pitted toward the center.

Secondary thickening follows by the activity of a complete cambial ring, which cuts off collateral xylem elements and phloem opposite the primary bundle strands, and radial rows of parenchyma cells in all the remaining space. In the third layer from the outside of the regular parenchyma cells, appears the single endodermal row of cells, as in the shoot, cutting off the spongy parenchyma from the inner regions. When three years' xylem shows in a section cut farther back (FIG. 9), the central strand is surrounded by an endodermis and parenchymalike active cells. The loose cortical parenchyma invades the center through the groove made by the entering of the outer endodermis, and the root is divided. The periderm surrounds the root, and in turn each division is completely protected by an active cork layer.

There is, then, complete correspondence in the method of splitting in rhizome and root.

In general it can be said that originally in the young seedling, rhizome and root must have been continuous and undivided. As secondary thickening, accompanied by abnormal changes in central and peripheral tissues, took place, necrosis occurred in the center and to a slight extent on the outside. Longitudinal sections show that the central disintegration is very irregular, being a wide region narrowing down at each end to a small neck which opens into another larger cavity, etc. Jost claims that there is a correspondence between the leaf position and the bundle courses, and between the bundle courses and the splitting. So far as this material can be examined, there seem to be no remaining leaf traces to affect the bundle course, which is apparently straight down through the rhizome and continued in the root. But as has been mentioned before, the columns always contain finally a single bundle strand. This column must necessarily continue its own existence independently, and it is apparently quite capable of doing so, having, as it does, an active outer cambium zone, which in successive years may circle farther and farther around inside of the limiting endodermal layer, perhaps finally forming, with the meristematic parenchyma on the inside, a complete ring around the column. No material of the age I have, shows such a complete ring, but in the four year old stage we have a very close approach to this state.

To summarize briefly the order of splitting for the rhizome, which is followed exactly in the root, we can say:

1. There is regular primary shoot structure.

2. The cambium ring produces annually some xylem and phloem tissue, but much parenchyma in the normal place of these elements. An endodermis ring appears between the outermost spongy cortex and the regularly formed outer parenchyma. Periderm surrounds the whole.

3. In the third year, an inner endodermislike ring cuts off the primary xylem and parenchyma enclosing a necrotic pith, from the rest of the tissues.

4. The outer endodermis pushes down between the xylem masses, joins the inner ring of like structure, making one con-

tinuous ring about each of the segments into which the rhizome is thus divided. The tissues cut off in this way become necrotic. Columns formed are each surrounded by an active cork-forming periderm, they continue an independent existence and never exceed the number of the original bundles.

This anatomical study of the rhizome and root of *Delphinium scaposum* was carried on in the Botanical laboratories of Barnard College, Columbia University, under the direction of Dr. Herbert M. Richards, to whose inspiration and helpful suggestions the success of this investigation is mostly due. The writer wishes also to express her thanks to Dr. D. T. MacDougal for furnishing the material, and to Dr. Tracy E. Hazen and Dr. P. A. Rydberg for their assistance in determining the identity of the plant studied.

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Explanation of plates 13 and 14

FIG. 3. Cross section of primary aerial stem, showing regular primary structure, bundle ring, hollow center, stereome.

FIG. 4. Cross section of rhizome in second year, showing irregular outer parenchyma with groups of stereome, outer endodermal ring separating regular and irregular cortex, cambium ring between 2nd xylem and phloem, slight necrosis around hollow center. Space outside 1st xylem shows ring of "fall" parenchyma cells. Periderm formed.

FIG. 5. Cross section of rhizome in third year, showing inner endodermis cutting off xylem of first year with enclosed irregular parenchyma and necrotic pith. Outer endodermis projected between xylem strands meets inner endodermis, dividing the rhizome into two parts. Other grooves appear in outer endodermis, indicating subsequent divisions.

FIG. 6. Cross section of rhizome in fourth year, showing separate columns cut off each with separate periderm, endodermis, cambium, etc. Center of section shows necrotic parenchyma tissue and disintegrating xylem ducts of first year. Second year xylem enclosed in irregular parenchyma that eventually disintegrates. Large air cavities in among broken cells of cortex.

FIG. 7. Detail of column as indicated in FIG. 6, showing irregular parenchyma and second year xylem, endodermis and parenchyma cells of inner endodermis, and brickshaped cells of third year xylem.

FIG. 8. Cross section of ultimate division (root). Diarch order with second year collateral bundles produced, connected by cambium ring. Axial strand in center. Root endodermis like shoot.

FIG. 9. Cross section of third year root. Xylem of first year cut out by inner and outer endodermis, becomes necrotic. Groove marks first break in root. Periderm formed as in shoot.

FIG. 10. Detail of endodermis of third year rhizome.

FIG. 3–10 inclusive (except 7) magnified about 8 diameters. FIG. 7 magnified 38 diameters.

All plan drawings made with Edinger apparatus, Leitz oc. I, obj. 1a; FIG. 7, oc. I, obj. 2.

KEY

air. . . . . .air cavities
c. . . . . .cambium
c.p. . . . . .cortical parenchyma
end. . . . . .endodermis
epi. . . . . .epidermis
i. end. . . . . .inner endodermis
n. . . . . .necrotic tissue
P. . . . . .phloem
par. . . . . .parenchyma
per. . . . . .periderm
s. . . . . .stereome
x. . . . . .xylem; x_1—xylem of first year, etc.
x.d. . . . . .xylem duct

Notes on certain species of Muhlenbergia

F. Lamson-Scribner

Muhlenbergia comata (Thurb.) Benth. Jour. Linn. Soc. 19: 83. 1881

Vaseya comata Thurb. Proc. Acad. Nat. Sci. Phila. 1863: 79. 1863.

The genus *Vaseya*, established upon this species, is characterized by Dr. Thurber as follows: "Panicula coarctata. Spiculae uniflorae, herbaceo-membranaceae. Glumae uninerves florem adaequantes. Callus obliquus, comam pilorum paleis aequilongam gerens. Palea inferior trinervis in aristam gracilem attenuata; superior aequilonga, acuminata. Stamina 3. Ovarium stipitatum. Styli ultra medium pilis stigmaticis longis simplicissimis instructi. Squamulae . . . Caryopsis . . . ." (Thurber l. c.)

The description of the species follows: "*V. comata*, a native of the plains of Nebraska, is a perennial grass, with the aspect of *Muhlenbergia* or of a *Polypogon*, but with a coma of silky hairs around the flower as in *Calamagrostis*. Culm a foot and a half high from a creeping rhizoma, retrorsely pubescent at the node. Sheaths scabrous, equaling the internodes; ligule short, fringed, leaves 3 to 4 inches long, dull green, rough on both sides. Panicle lead-colored, about 3 inches long; the branches solitary, appressed, densely many-flowered. Spikelets very short-pediceled, compressed, pubescent, a line and a half long. Glumes narrow, very acute, serrulate on the keel, the lower a little the longer. Awn rough and flexuose, purplish, three to four lines long." (Thurber l. c.)

A rather stout erect perennial 3–5 dm. high from creeping scaly rootstocks, with simple culms, flat leaves, densely flowered oblong or cylindrical panicles and awned spikelets 3–4 mm. long; culms very finely pubescent at the nodes and for a short distance below them with reflexed hairs; sheaths glabrous, the lower ones more or less compressed; leaf blades mostly erect, rather firm in texture, 6–15 cm. long, the lowermost shorter, acute or attenuate-pointed; panicles ovate-oblong or cylindrical, 2–10 (usually about 7) cm. long, densely flowered and more or less lobate, lead-colored,

pale green, light straw-colored or rose tinted; glumes 3–4 mm. long, subequal, narrowly lanceolate or linear, acuminate, sometimes pointed with a short awn, aculeolate-scabrous on the keel excepting near the base, as long as or slightly exceeding the lemmas; lemmas lanceolate, thin-membranaceous, copiously hairy near the base; hairs 1.5–2 mm. long; awns very slender, scabrous, 2–7 mm. long, paleas lanceolate-acuminate, acute or minutely 2-toothed, nearly as long as the lemmas and similarly hairy near the base.

This species is represented in the National Herbarium by specimens from Colorado, Wyoming, Montana, Idaho, Utah, Nevada, Arizona, Washington, Oregon, and California. Specimens from the Rocky Mountain region generally have lead-colored panicles as in the type, those from Washington, Oregon, and California have pale green or very light straw-colored ones, while some of the Californian specimens have violet or rose tinted panicles. These last may prove to be separable as a distinct species.

Among the numbered specimens of this species in the National Herbarium are the following:

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UTAH: *C. A. Purpus 6375*, 1898; *M. E. Jones 5731a*, 1894.

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MONTANA: *P. A. Rydberg 3411*, 1896.

WASHINGTON: *A. D. E. Elmer 558*, 1897.

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M. neo-mexicana Vasey, Bot. Gaz. **11**: 337. 1886.
M. Pringlei Scribn. Trans. N. Y. Acad. Sci. 14. 1894, and Vasey in Contr. U. S. Nat. Herb. **3**: 71. 1892.

Original description: "Culmo subdecumbente 12–18 pollicari; foliis convolutis apice setaceis glabriusculis; vaginis internodio parum brevioribus; ligulis membranaceis linearibus subobtusis; paniculis 2–3 pollicaribus interruptis paucifloris; glumis ovatis acutis aequalibus subcarinatis valvula 2/3 brevioribus; valvulis lanceolatis inferiore valde 3-nervia et longe aristata; spiculis rufescentibus; carinis et nervis subviridescentibus.

"Hillsides Western Texas.

"Panicle terminal with short appressed branchlets of 4–6 flowers each of a brownish red color, bristles longer than the flowers." (Buckley l. c.)

Dr. Gray (Proc. Acad. Nat. Sci. Phila. **1862**: 334. 1863) says that Buckley's *M. pauciflora* is "described from a scanty depauperate specimen of Wright's *no. 732*." This number is represented in the National Herbarium and according to the ticket was "collected in Expedition from Western Texas to El Paso, New Mexico, Oct., 1849." The specimen is branched at the lower nodes, which show a malformation apparently caused by a mite, and it is probable that the branching of the culms in this specimen is due to these insect attacks. The effect of insect work is further manifest in a more or less imperfect development of the panicle and spikelets. Similar specimens were collected in the Guadaloupe Mts. of western Texas by Dr. V. Havard in 1881. In both Wright's and Havard's specimens the glumes are broadly ovate, barely acute or abruptly short-cuspidate at the tip, and about half the length of the lemmas, which are naked at the base. The entire absence of hairs at the base of the lemmas is a further indication of abnormality in this case. In apparently healthy and normal plants the slender wiry erect culms are unbranched, the panicles rather more densely and abundantly flowered, the glumes are somewhat longer and with long-subulate points often equaling the lemmas, which are barbate on each side at the base with a dense tuft of very short hairs. The type of *M. neo-mexicana* Vasey from Las Vegas, New Mexico, and of *M. sylvatica Pringlei* from the Santa Rita Mts. of Arizona, collected by C. G. Pringle in 1881, are normally developed specimens of the species *M. pauciflora*, although Pringle's specimens are immature. The original description of *M. sylvatica Pringlei* differs somewhat from

that of *M. pauciflora*, doubtless due to the condition of the specimens as noted above. "Culms densely caespitose, terete, erect, simple, rather rigid, about 1 ft. high. Leaves involute, filiform, about 7 to each culm, minutely scabrous outside, especially towards the tip, strigose scabrous within, 4–6 in. long, the lower ones shorter; ligules broader than the leaves, decurrent along the sheath, ½ line long, irregularly cut, continued on each side into two lanceolate, acute teeth or auricles one line long. Panicle slender, contracted, 2–3 in. long, rather densely flowered. Empty glumes nearly equal, 1–nerved, with slender acuminate points, 1 line long. Flowering glume nearly or quite smooth at the base, 3–nerved, scabrous on the keel above, 1½–2 lines long, terminating in a slender awn 4–6 lines long. Palea nearly equaling its glume.

"Dry cliffs, Santa Rita Mountains, alt. 7,000 ft. July. [*Pringle*] *480*." *

There are two sheets of specimens in the National Herbarium, collected and labeled by Dr. Vasey himself, *M. neo-mexicana*, one from Watrous, New Mexico, 1884, and one from Las Vegas, New Mexico, collected in 1886. On both tickets there is written in Dr. Vasey's hand "published in Bot. Gazette, Dec., 1886."

In the original description of *M. neo-mexicana* the type is not indicated. Probably several specimens were consulted in drawing up the diagnosis, for the range is given as "New Mexico and Arizona," and the culms are described as "mostly branched near the base from thickened nodes." The Las Vegas specimens have simple culms while the Watrous specimen is branched as described by Vasey, and this specimen is assumed to be the type of his species.

Among the numbered specimens in the National Herbarium referred to *M. pauciflora* Buckl. as here understood are the following:

TEXAS: *C. Wright 732*, 1849.

COLORADO: *Frank Tweedy 391*, 1896.

NEW MEXICO: *E. O. Wooton 1047*, 1893; *F. S. Earle 164*, 1900 (culms branched, panicles strict, 5–10 cm. long); *E. W. D. Holway*

*The "*no. 480*" here cited was a private number for the collection made by Pringle in 1881 and is not the *no. 480* of his distributed sets of 1884.

21, 1896; *M. E. Jones 37a bis*, 1884; *H. H. Rusby 465*, 1880; *E. O. Wooton 333*, 1897; *E. N. Plank 36*, 1895.

ARIZONA: *F. X. Holzner 2177*, 1893; *D. T. MacDougal 779*, 1891; *G. C. Nealley 168*, 1891 (much like the type of *M. pauciflora*); *Griffiths & Thornber 170*, 1902; *Griffiths 7351*, 1904; *Griffiths 7227* and *7229*, 1904; *Griffiths 6029*, 1903; *J. G. Lemmon 410*, *J. G. Emersley 15* and *17*, 1890 (panicles 12 cm. long; glumes with long attenuate bristlelike points); *G. C. Nealley 167*, 1891 (the bristlelike tips of the glumes nearly equaling the lemmas in some of the spikelets in others only about one half as long).

MEXICO: *C. V. Hartman 754* and *793*, 1891.

MUHLENBERGIA PARISHII Vasey, Bull. Torrey Club **13**: 53. 1886

M. sylvatica californica Vasey, Bot. Gaz. **7**: 93. 1882.
M. glomerata brevifolia Vasey, Bot. Gaz. **7**: 92. 1882.
M. californica Vasey, Bull. Torrey Club **13**: 53. 1886.

Muhlenbergia sylvatica californica and *M. glomerata brevifolia* were published simultaneously by Dr. Vasey in 1882. In 1886 the same author raised both these supposed varieties to specific rank, the first, *M. sylvatica californica*, he named *M. Parishii*, and the second, *M. glomerata brevifolia*, he called *M. californica*.

The description which appears under *M. glomerata brevifolia* Vasey (Bot. Gaz. **7**: 92. 1882) is as follows: "Culms 1–2 ft. high, erect and leafy, leaves (5–8 on each culm) rigid, short and wide (2–4 in. long 2–3 lin. wide) somewhat scabrous; panicle spikelike, interrupted and with longer branches below; glumes and palets about equal in length (1 line); glumes acuminate, scabrous-puberulent; flowering glumes acuminate and tipped with an awn half its length or less, 3-nerved, pubescent below; palet acute about equaling the flowering glume."

No types are mentioned by the author for either *M. Parishii* or *M. californica*, but they were both collected in San Bernardino County, California, by the Parish Brothers, in 1881, the first distributed under *no. 1076* and the second under *no. 1028*. The specimens so numbered in the National Herbarium must be regarded as the types, *no. 1076* being the type of the species as here

treated, although *no. 1028* represents the usual form as shown by more recently collected material, for example *nos. 2113* and *2116*, collected by S. B. Parish in 1890, both from the region of the San Bernardino Mountains.

The following is a description of the species *M. Parishii* as here understood:

An erect, rigid, rather stout glabrous perennial 4–6 dm. high, from creeping woody rootstocks, with many-jointed culms, fasciculate-branched at the base, flat, scabrous leaves, densely flowered contracted panicles, and scabrous spikelets 3–4 mm. long. Culms minutely scabropubescent for a short distance below the nodes; nodes usually seven; sheaths mostly longer than the internodes, terete or slightly compressed, scabrous; ligule about 1 mm. long, lacerate and subciliate on the margins; leaf blades usually erect or ascending, rather rigid, very acute, 3–12 (usually 5–7) cm. long, 3–8 (usually about 5) mm. wide, the margins more or less revolute in drying; panicles 6–12 cm. long, lanceolate or linear in outline, more or less interrupted below; branches of the panicle erect or appressed, solitary or the lower in pairs, densely flowered to the base, or the longer lower branches naked below; spikelets broadly lanceolate, somewhat compressed, crowded and more or less glomerate, sessile or on very short pubescent pedicels; glumes broadly lanceolate, acute, acuminate, or pointed with a short awn, rather firm in texture, scabrous, strongly so on the prominent midnerve excepting near the base, nearly equal, as long as or a little shorter than the lemmas; lemmas broadly lanceolate, 3–4 mm. long, scabrous, copiously hairy near the base with hairs about 1 mm. long, awned or nearly awnless; awn when manifest rarely exceeding 2 mm. in length; palea broadly lanceolate or oblong, acute or minutely 2-toothed at the apex, hairy near the base and similar in texture to the lemma. The hairs at the base of the lemmas and paleas vary in length and in abundance but are always conspicuous.

Allied to *M. Lemmoni* Scribn. but differing in the stouter culms, broader leaves, and larger and more scabrous spikelets.

No. 1076, *Parish Brothers*, from the San Bernardino Mountains of Southern California, collected in July, 1881, and now in the National Herbarium, is assumed to be the type. A second, and the only other specimen in the National Herbarium, was collected in 1882 by the Parish Brothers and distributed under the same number (*1076*). They both represent luxuriant forms of Vasey's *M. californica*, differing only in a more rank development of the

culm and leaves, due doubtless to peculiarities of environment. The culms are 6–8 dm. long, leaves 10–18 cm. long, and panicles 10–16 cm. long. In all essential characters they are identical with *M. californica* and we have no hesitation in uniting the species.

MUHLENBERGIA LEMMONI Scribn. Contr. U. S. Nat. Herb. 1: 56. 1890

M. huachucana Vasey, Contr. U. S. Nat. Herb. 3: 69. 1892.

Original description: "Culms much branched below, slender, erect or decumbent, 30–45 cm. high; leaves 2.5–7.5 cm. long, 2 mm. wide, acuminate; panicle spikelike, 5–12.5 cm. long, interrupted below, the upper branches sessile, the lower pediceled and subdivided, sometimes 2.5–5 cm. long, erect; spikelets about 3 mm. long without the awns; empty glumes ovate-lanceolate, awn-pointed, nearly equal and but little shorter than the flowering glume, which is hairy below and with an awn half as long as itself. Ballinger (Runnels Co., Tex.) (G. C. Nealley)." (Scribner l.c.)

Type, *G. C. Nealley 726*, 1890, in National Herbarium. The sheet containing this specimen has also a ticket upon which "Type No. 1079" is inscribed.

The original description of *M. huachucana* is very similar to the above. It is as follows: "Culms tufted, much branched at the base, 12–18 in. high, leafy; leaves 4–6 in. long, 2 lin. wide, erect, rather rigid, scabrous; panicle 2–4 in. long, narrow, the lower branches sometimes in twos, all densely flowered, erect, contiguous; spikelets 2 lin. long, sessile; empty glumes about equal, 1½–2 lin. long, ovate, acuminate-pointed, the long points scabrous; flowering glumes about 3 lin. long, 3-nerved, with a short awn; palet about as long as its glumes. Both flowering glume and palet villous-pubescent below. Huachuca Mountains, Arizona, J. G. Lemmon." (Vasey.)

The type of *M. huachucana* is not indicated by the author of that species, but there are two specimens in the National Herbarium so named by Dr. Vasey himself both of which were collected by J. G. Lemmon, one in July 1882, *no. 2915*, Huachuca Mts., Arizona, the other in 1883, *no. 392*, Arizona, without other data.

The first specimen collected, *no. 2915*, is assumed to be the type. It agrees throughout with the type of *M. Lemmoni*, and is certainly identical with that species.

Revised diagnosis of *M. Lemmoni:*

A slender, wiry, erect or ascending, leafy perennial, 3–5 dm. high from creeping woody rootstocks, with narrow flat scabrous leaves, strict, densely flowered panicles and short-awned or awnless spikelets, 3–4 mm. long. Culms fasciculately branched at the base, very minutely scabropubescent at and for a short distance below the nodes; sheaths terete, usually exceeding the internodes in length, glabrous or minutely pubescent towards the base; ligule about 1 mm. long, more or less lacerate, ciliate on the edge; leaves 7–8 on each culm, 2–5 cm. long, 1–3 mm. wide, minutely strigose-pubescent above, scabrous on the back, revolute in drying, with slender attenuate tips; panicles 5–10 cm. long, main axis triangular or compressed, scabrous, the lower branches often in pairs, 1–2 cm. long, the upper usually solitary and flower-bearing to the base, all erect or appressed; spikelets densely crowded and more or less glomerate on very short pubescent pedicels; glumes broadly ovate-lanceolate, abruptly acuminate and subaristate or pointed with a short awn, varying to lanceolate and gradually acuminate, nearly equal, as long as or a little shorter than the lemmas, scabropubescent on the keel above, glabrous towards the base; lemmas 3–3.5 mm. long, broadly lanceolate or ovate, minutely 2-toothed at the apex, rather densely villous from near the middle to the base; awns 1–2 mm. long, occasionally reduced to a mere mucro, very rarely 5–6 mm. long; palea broadly lanceolate or oblong, about equaling the lemmas, villous in the lower half.

This species is represented in the National Herbarium by the following specimens:

TEXAS: *G. C. Nealley 132*, 1892; *no. 397* from the Chico Mts., 1889 (a nearly awnless form); *G. C. Nealley 726*, the type.

ARIZONA: *J. G. Lemmon 392*, 1883 (plant a little coarser than usual and panicles more densely flowered); *Lemmon 2915*, 1882, from the Huachuca Mts. (type of *M. huachucana* Vasey); *Canby 58*, 1894 (resembles the following specimens collected by Wilcox, in having awns 5–7 mm. long). Specimens from the same region collected by Dr. T. E. Wilcox, distributed without number, have awns 5–10 mm. long. This is a form apparently connecting *M. Lemmoni* with the next species.

MEXICO: *Pringle 395*, 1885; *Pringle 8263*, 1889, from the

Federal District, alt. 8500 ft.; *Pringle*, 1893 (lemmas barely mucronate-pointed and scabrous near the tip, a form approaching the allied *M. Parishii*).

Muhlenbergia polycaulis Scribn. sp. nov.

A slender, wiry, erect, or ascending, glabrous, leafy perennial, 3–4 or 5 dm. high, from creeping rootstocks, with linear attenuate-pointed, scabrous leaves, slender, rather densely flowered panicles, and long-awned spikelets 3–4 mm. long; culms terete, fasciculately branched at the base, glabrous or minutely scabropubescent below the nodes; sheaths scabrous, terete, longer than the internodes; ligule about 1 mm. long, ciliate on the edge and more or less lacerate; leaves about 7 on each culm, 2–6 cm. long, 1–2 mm. wide or less; panicles 5–10 cm. long, main axis scabrous, flattened or triangular and somewhat flexuose; branches solitary or the lower ones in pairs, the lowermost somewhat remote and 2–4 cm. long, the upper shorter and approximate, all erect or appressed; spikelets not crowded as in *M. Lemmoni*, the longer branches naked below, pedicels scabropubescent, nearly equaling or much shorter than the spikelets; glumes subequal, a little shorter than the florets, broadly ovate-lanceolate or lanceolate, very abruptly mucronate or short-awned, scabropubescent on the keel above, smooth below; lemmas broadly lanceolate, minutely 2-toothed at the apex, densely villous in the lower half; palea lanceolate-oblong, nearly equaling the lemma in length and similarly villous in the lower half; awn very slender and hairlike, more or less flexuose, 10–24 (usually about 20) mm. long.

Type, *C. G. Pringle 1414*, 1887.

Closely allied to *M. Lemmoni*, but more slender, with narrower leaves, long-awned and less crowded spikelets.

This species is represented in the National Herbarium by the following specimens:

TEXAS: *S. B. Buckley*, no number.

ARIZONA: *C. G. Pringle 480*, 1884 (not *480* of the collection of 1881); *Griffiths 7036*, 1904. Panicle more loosely flowered than in the type, and glumes purplish.

MEXICO: *Pringle 394*, 1885; *Pringle 1414*, collected on dry shaded ledges, Sierra Madre Mts., State of Chihuahua, Sept. 30, 1887; *Pringle 394*, 1885; *E. Palmer 592* and *724*, 1896.

Muhlenbergia curtifolia Scribn. sp. nov.

A slender wiry perennial, 1–2 dm. high, fasciculately branched at the base from creeping rootstocks, with short rigid leaves, linear panicles and short-awned spikelets 3–3.5 mm. long; culms pubescent below the nodes; leaves 7–10 on each culm, rather crowded near the base, the upper more distant; sheaths, excepting the upper ones, longer than the internodes, pubescent, especially toward the base; ligule less than 1 mm. long, ciliate on the edge; blades 1–2.5 cm. long, 2 mm. wide or less, pungent at the acute apex, scabropubescent on both sides; panicles 4–8 cm. long with erect appressed branches 1–3 cm. long or less, the main axis triangular or compressed, scabropubescent; spikelets on short, slender, pubescent pedicels; glumes lanceolate acute, subequal, a little shorter than the florets, scabrous at the tip and along the keel near the apex; lemmas broadly lanceolate, villous from just above the middle to the base, scabrous near the apex, gradually tapering into a slender scabrous awn 1–3 mm. long; palea as long as the glume and similarly hairy.

Type, *Marcus E. Jones 6047j*, 1894, collected between Kanab and Carmel, Utah, alt. 6,000 ft.

Muhlenbergia curtifolia Griffithsii Scribn. subsp. nov.

More slender throughout and wholly glabrous, with the narrower leaves spreading or deflexed and the linear panicles loosely few-flowered.

Type, *David Griffiths 5837*, 1903, collected in Du Chelly Canyon, Arizona.

U. S. DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.

A Pliocene flora from the Coast Ranges of California

HAROLD HANNIBAL

(WITH PLATE 15)

GENERAL REMARKS

The origin and development of the California floras, particularly the peculiar xerophytic chaparral, has been a problem of no small interest to students of phytogeography. The occurrence in the Coast Ranges of a recognizable Pliocene flora, the only thing of its kind known in North America consisting entirely of living species, partly mesophytic and partly xerophytic in character, throws an interesting light upon the antiquity of these floras and suggests a possible explanation of the isolation of boreal and arctic plants on the upper slopes of high mountains of the state far south of their normal ranges.

THE SANTA CLARA FORMATION

WORK OF PREVIOUS WRITERS

The Santa Clara formation was named and described by Cooper[1] in 1894. The deposit was considered to be of lacustrine origin and referred to the Pliocene on the basis of its general lack of consolidation, the gentle tilting of the beds, and the large percentage of recent species in the molluscan fauna. It had been previously described in some detail by Lawson,[2] however, who also regarded it as Pliocene in age, but of delta origin. The portion lying in the Santa Cruz Quadrangle has been discussed by Arnold[3] and again by Branner, Newsom, and Arnold,[4] its distribution being shown in map form. Recently Jones,[5] solely on lithological grounds, has tentatively suggested its contemporaneity with what has been termed by Lawson and Palache[6] as the Orindan forma-

[1] Proc. Calif. Acad. Sci. 4: 171. 1894.
[2] Bull. Dept. Geol. Univ. Calif. 1: 151. 1893.
[3] Proc. U. S. Nat. Mus. 34: 355. 1908.
[4] Santa Cruz Folio, U. S. Geol. Surv. 6. 1909.
[5] Bull. Dept. Geol. Univ. Calif. 6: 71. 1911.
[6] Bull. Dept. Geol. Univ. Calif. 2: 371. 1902.

tion, and earlier by Cooper[7] as the Contra Costa, a fresh-water deposit of late Miocene age in the Berkeley Hills. The faunal evidence does not bear out such a correlation.

CHARACTER AND DISTRIBUTION OF BEDS

The formation consists of a well-bedded series of clays, slits, and sands with minor gravel strata, of wide extent, underlying and outcropping about the edges of the Livermore, Santa Clara, and San Benito valleys. A large mass fills a formerly extensive depression southwest of Mt. Hamilton, of which San Felipe Valley is a part. Remnants extend south as far as Cook P. O. in San Benito County, a distance of nearly a hundred miles from Livermore. The occurrence of sediments about Portola, thirty miles west of the latter point, indicates a considerable breadth at this latitude. The northward extension of the former lake is uncertain, since the sinking of the San Francisco Bay region in comparatively recent times has permitted the burial of its sediments beneath the valley alluvium.

The thickness of the series is not inconsiderable, but varies widely. In the foothills near Tres Pinos fully 1,000 feet of nearly horizontal strata overlie the Miocene, while the top of the series is cut off by erosion. A section down Calabazas Cañon in the Santa Cruz Mountains, without exposing the basal beds, was estimated to be 3,000 feet in thickness to a point where the upper strata are similarly absent.

It is highly probable that the entire Santa Clara formation was deposited at or comparatively near sea level. The character of the flora furnishes proof that the elevation could hardly have been greater than 1,000 feet and was probably much less. It is difficult to conceive that a single body of water, or quite as probably several connected bodies, of this extent could exist at any considerable elevation in proximity to the ocean continuously for a sufficient period of time to deposit over half a mile of sediments without draining the lake by stream corrosion alone. The enormous thickness of the beds is perhaps explainable on the assumption that the valleys acted as catchment basins with the bottoms sagging beneath the load of sediments. It might be added that

[7] Proc. Calif. Acad. Sci. 4: 169. 1894.

there is a general tilting of the strata toward the middle of each of the three valleys.

The source of the waters which supplied this vast lake, and the outlet to the ocean are uncertain. The large proportion of coarse material in the southern portion of the San Benito Valley suggests that a stream of no small size entered here. It is by no means improbable that the vast expanse of water was kept up by the run-off of the Great Valley of California, through the precursors of the Sacramento and San Joaquin rivers. The lake doubtless fluctuated widely and a considerable proportion of the sediments about the border may have been deposited under fluvial conditions.

FAUNA

Aside from the plant remains, the formation contains a fauna consisting almost entirely of aquatic mollusca,[8] of which a large percentage, six out of ten species, still exist in the waters of northern California.

In the following list the species marked with an asterisk are living.[9]

* *Anodonta cygnea impura* Say
Gonidea angulata Cooperi Arnold
Sphaerium sp. nov
* *Corneocyclas compressa* Prime
* *Planorbis trivolvis* Say
* *Physa "heterostropha* Say"
"*Carinifex*" *Sanctae-clarae* Hannibal
* *Paludestrina longinqua* Gld.
"*Amnicola*" *Yatesiana* Cooper
* *Valvata "virens* Tryon"

[8] Mr. John Hain, of Cook, California, obtained a leg bone of an extinct Proboscidian from these beds near Tres Pinos. So far as the writer is aware no other recognizable mammal remains have been found in the formation.

[9] Names in quotation marks are subject to revision in a forthcoming paper on the fauna of the Santa Clara formation. *Amnicola Yatesiana*, which in reality belongs to the allied genus *Phyrgulopsis*, is confined to these beds. The genus appears to be valuable for horizon determination in the later Tertiary fresh-water deposits of California.

GEOLOGIC RELATIONS

The youngest formation antedating the Santa Clara is the Purisima, a marine deposit, older Pliocene in age. The Purisima is confined chiefly to the ocean front, but an embayment extended from Half Moon Bay and Pescadero across the Santa Cruz Mountains past La Honda and Portola to the hills near Stanford University and the mouth of Stevens Cañon, while another arm extended inland from Santa Cruz to the vicinity of Chittenden.

The relation of the Santa Clara to the underlying Purisima formation, along the flanks of the Santa Cruz Mountains is probably one of decided unconformity, though the incoherence of the beds has prevented its actual observation. The tilting of the Purisima, which is apparently somewhat greater than that of the Santa Clara, and the differences in distribution of the two indicate that important structural movements took place in the interval previous to the opening of the Santa Clara period.

The older Pliocene through the Coast Ranges appears to have been a period of peneplanation. The movements which preceded the Santa Clara epoch developed the general outlines of the present topographic features. The relief of the mountain ranges was, however, far more gentle than at present, and the elevations of the mountains themselves decidedly less.

Since the deposition of the Santa Clara, several important geologic events have taken place in the history of the Coast Ranges.[10] Following the Santa Clara sedimentation, apparently without the intervention of any other deposits, the entire Coast Ranges were lifted more or less bodily, carrying the old lake level to an elevation of perhaps 4,500 feet above the sea. Rapid erosion ensued and the soft lacustrine beds were cut into deeply, far below the present valley floors. This period of intense elevation and erosion called the Sierran epoch, was widespread in California. It is regarded as marking the opening of the Quaternary, corresponding at least in part to the Glacial epoch of elevated or more northern regions. Subsequently a period of depression ensued, succeeded by temporary oscillations, which have continued to the present. The beds of the Santa Clara formation in the San Benito Valley

[10] Lawson, A. C. Bull. Dept. Geol. Univ. Calif. 1: 115, 242. 1893. Smith, J. P. Science II. 30: 346. 1909.

and about Evergreen and Los Gatos in the Santa Clara Valley now reach an elevation of 1,200 to 1,500 feet.[11]

The unconformable deposition of the valley alluvium upon the Santa Clara has taken place more or less continuously since the close of the Sierran epoch. At Madrone, as an alluvial fan of the Coyote River, it reaches the maximum elevation of 345 feet.[12] At least a portion of the alluvium must be referred to the Quaternary from the presence of mammal remains characteristic of that age in gravels near Mountain View.[13] Hence it must not be assumed that the Sierran epoch, though a very long period, was coincident with the entire Quaternary.

The latest event, and a purely local one, has been the sinking of the San Francisco Bay region, causing a flooding of the Golden Gate River system by the tides. As a result the Santa Clara sediments reach an elevation of not more than 500 feet at Mission San Jose, north of that point they largely disappear beneath the later alluvium.

AGE OF THE FORMATION

The Santa Clara formation may be regarded as having been deposited during late Pliocene time. It occupies an unconformable position upon the Purisima, a marine formation of older Pliocene age. It contains a molluscan fauna of which two-thirds of the species are still living. The strata were intensely elevated and eroded subsequent to their deposition, during the Sierran epoch, early Quaternary.

The Santa Clara is presumed to be contemporaneous with the Deadman Islands formation of San Pedro Harbor, Santa Monica Cañon, and Packard's Hill, Santa Barbara, a marine deposit occupying an analogous stratigraphic position in southern California.

LOCALITIES WHERE PLANTS WERE OBTAINED

Plant remains are abundant almost everywhere in the Santa Clara formation, but recognizable material has been obtained

[11] In the vicinity of Bird Creek, near Hollister, the beds, in a disturbed condition, reach an elevation of 1800 or 1900 feet. This is probably produced by local conditions, due to the proximity of the San Andreas fault, along which the earthquake of 1906 took place.

[12] Branner, J. C. Jour. Geol. 15: 3. 1907.

[13] Santa Cruz Folio, U. S. Geol. Surv. 1909: 6.

from only five localities, and by far the larger part was derived from two. No doubt careful search would have revealed many more and would materially extend the flora, but the incoherent character of the beds restricts collecting to fresh exposures, to be found only in cañons and gorges. Furthermore, collecting is possible only during the summer and fall months after the matrix has dried out sufficiently to stand transportation to the laboratory.

The localities are as follows:

PORTOLA: gulch below Holliday's ranch in creek-cut about 1,000 feet above mouth of gulch, ⅛ mile south of Portola, Santa Cruz Mountains. The mollusk beds just below this point have been known for a number of years to the Stanford University Geological Survey. Plant beds were found by the writer in 1908. Subsequently collections were made in 1909 and 1910, and in connection with Dr. J. P. Smith and party of students in 1910.

STEVENS CAÑON: creek-cut just above "big camp ground," a flat planted with *Eucalyptus* trees, about 1½ miles above mouth of gorge, Stevens Cañon, Santa Cruz Mountains. Found by W. G. Hannibal, the writer's father, in 1909. Subsequently visited in connection with Dr. Smith and party of students, 1910. The material consists almost solely of *Salix* and lignitized wood.

CALABAZAS CAÑON: "reef" in creek bed at nose of bend above second wagon bridge, ¼ mile from mouth of gorge, Calabazas Cañon, Santa Cruz Mountains. Found by the witer in 1908, subsequent collections made in 1909 and 1910, in connection with Dr. Smith and party of students in 1910, and with Mr. H. M. Edson of Palo Alto in 1910.

SOLLY RANCH: near a spring tunnel on Solly Ranch north of Bird Creek, ¾ mile west of old dairy on mesa above San Benito River, and 4 miles southwest of Hollister, Gavilan Range. This locality was discovered a number of years ago by the owners of the ranch when digging for water. A specimen is contained in the collection of the late Miss Annie R. Laws, now the property of the Geological Museum at Stanford University. The locality was visited by the writer in 1908 and again in 1910 with Mr. Edson. All the best material was derived from the tunnel.

BEAR VALLEY: forks of a small gulch below limestone hill, over ridge 2 miles northeast of Cook P. O., Bear Valley, Gavilan

Range. Mr. John Hain, an old resident of Bear Valley, interested in natural history, pointed out this locality to Dr. C. H. Gilbert a number of years ago. It was subsequently visited by Dr. Smith, Mr. Fordyce Grinnell, Jr., and the writer in 1907, and by the writer in 1910. The main exposure apparently represented an old tule bed, consisting of an interlacing mass of indeterminate carbonized stems in peaty clay. Farther up the same branch of the gully a few fairly well preserved leaves were obtained.

LIST OF PLANTS OBTAINED FROM THE SANTA CLARA FORMATION

	Portola	Stevens Cañon	Calabazas Cañon	Solly Ranch	Bear Valley
Alnus rhombifolia Nutt.	A		X	A	
Amelanchier alnifolia Nutt.			X		
Arbutus Menziesii Pursh	R				
Arctostaphylos Manzanita Parry	R		R		
Cephalanthus occidentalis L.	R		X		
Cercocarpus betulaefolius Nutt.			R		
Cornus glabrata Benth.			A		R
Grossularia Menziesii (Pursh) Cov. & Britt. (?)	R		X		
Padus demissa (Nutt.) Roem.	R		X		R
Pasania densiflora (Hook. & Arn.) Oerst.	A		X		R
Populus trichocarpa Torr. & Gray	A				
Pseudotsuga taxifolia (Poir.) Britt. (?)			R		
Psoralea physodes Dougl.			X		
Quercus agrifolia Née			R		
Quercus chrysolepis Lieb.	X		A		
Rhamnus californica Esch.			R		
Rhamnus Purshiana DC.	X				
Salix fluviatilis Nutt. (?)			A		
Salix laevigata Bebb	A	A	A	R	
Sequoia sempervirens (Lamb.) Endl.	X				

A abundant, X not common, R rare.

NOTES ON SPECIES[14]

PINACEAE

Pseudotsuga taxifolia (Poir.) Britton. Douglas spruce.

A single badly water-worn cone unlike that of any other western conifer is referred with doubt to this species.

A common conifer in the yellow pine belt, particularly the upper portion, and fog belt. British Columbia and South Dakota south to Monterey County, California, northern Mexico, and western Texas.

[14] Determinations have been made in each instance by comparison with recent material in the Stanford University Herbarium.

Sequoia sempervirens (Lamb.) Endlicher. (PLATE 15, FIG. 3.) Redwood.

The characteristic species of the fog or redwood belt of the Coast Ranges. California-Oregon boundary to Monterey County, California.

SALICACEAE

Salix laevigata Bebb. Bebb willow.

Occurs along streams, its zonal distribution being determined by stored water rather than by rainfall. Siskiyou County, California, to northern Lower California.

Salix fluviatilis Nuttall. Long-leaf willow.

The resemblance of the leaf parts of *S. exigua*, *S. argophylla*, and *S. fluviatilis* renders it impossible to decide which of the three the series at hand should be referred to. It is not generally agreed that the several members of the *fluviatilis* group represent more than a single polymorphic species.

Sand bars along valley streams. British Columbia, Mackenzie Basin, and southeastern Canada south to Lower California, northern Mexico, and the District of Columbia.

Populus trichocarpa Torrey and Gray. Black cottonwood.

Several of the specimens show the characteristic anastomosing venation and cordate bases of leaves from young shoots.

Along foothill streams in moist situations, usually with *Acer californicum* and *Fraxinus oregona* in central and northern California. Occurs from southern Alaska east to Montana and south to San Diego County, California.

BETULACEAE

Alnus rhombifolia Nuttall. (PLATE 15, FIG. 6.) White alder.

Occurs along foothill and low mountain streams. Eastern Washington and Idaho south to San Diego County, California.

FAGACEAE

Pasania densiflora (Hook. & Arn.) Oerst. (PLATE 15, FIG. 8.) Tanbark oak.

The venation of this species is unmistakable.

Characteristic of the yellow pine and fog belt, but extending

a short distance beyond Sequoia into the chaparral belt. Southwestern Oregon to Santa Barbara and Mariposa counties, California.

Quercus chrysolepis Liebmann. (PLATE 15, FIG. 2, 9.) Cañon oak.

Several acorn cups and a large series of leaves, nearly all of the small smooth form from mature trees, are at hand.

A characteristic member of the more humid portions of the chaparral belt. Southwestern Oregon to northern Lower California.

Quercus agrifolia Née. Live oak.

A species of wide zonal distribution, occurring in the redwood, yellow pine, foothill, and chaparral belts. Mendocino County, California, to northern Lower California.

GROSSULARIACEAE

Grossularia Menziesii (Pursh) Coville & Britton. Cañon gooseberry.

A number of specimens agree fairly well with this species. The identification is a doubtful one, however, since the leaves of the members of this genus are not readily distinguishable.

Stream banks, southern Oregon, south nearly to San Francisco Bay in the Coast Ranges.

ROSACEAE

Cercocarpus betulaefolius Nuttall. Birch-leaf mahogany.

A typical chaparral shrub. California-Oregon boundary south to northern Lower California.

MALACEAE

Amelanchier alnifolia Nuttall. Western serviceberry.

A single specimen having the strong frequent venation and smooth margin of the form called *A. pallida*.

Chaparral belt. Alaska east to Lake Superior, south to California-Mexico boundary and New Mexico.

AMYGDALACEAE

Padus demissa (Nuttall) Roemer. Western chokecherry.

The impressions show little of the serrated margins character-

istic of this species. This is due doubtless to state of preservation, since it is more or less true of the other serrate species as well.

Best developed in the more humid portions of the chaparral belt, but extends into more arid portions on the one hand and into the redwood and yellow pine belts on the other. Northern British Columbia east to the Rockies and south to northern Lower California.

FABACEAE

Psoralea physodes Douglas. Chaparral psoralea.

Several imperfect specimens of the broad-leaved form were secured.

Characteristic of the more humid portions of the chaparral belt. Humboldt to Los Angeles counties, California.

RHAMNACEAE

Rhamnus Purshiana De Candolle. (PLATE 15, FIG. 10.) Cascara sagrada.

The material at hand shows no tendency to intergrade with the following species though the latter is regarded by some as a subspecies of *R. Purshiana.*

Cañons and river bottoms of the fog belt. Puget Sound region and Idaho south to Mendocino County, California.

Rhamnus californica Eschscholtz. (PLATE 15, FIG. 7.) California coffeeberry.

Occurs chiefly in the intermediate zone between the fog belt and chaparral belt, frequently on open hillsides, but extending into the chaparral with *Arbutus.* Humboldt County, California, to northern Lower California.

CORNACEAE

Cornus glabrata Bentham. (PLATE 15, FIG. 4.) Bentham's dogwood.

Most of the Calabazas Cañon material shows a pair of strong lateral veins near the base of the leaf. The character is more pronounced than in most of the herbarium material examined. The specimen figured retains traces of the original leaf structure.

Foothill streams in rather moist situations. Humboldt County south to Monterey County, California.

ERICACEAE

Arbutus Menziesii Pursh. (PLATE 15, FIG. 1.) Madrono.

The character of the venation in the only specimen obtained is decidedly more infrequent than usual in this species. It is possible that additional material will necessitate its specific separation.

Best developed with the redwood, but extends into the chaparral, yellow pine, and foothill belts. Southern British Columbia to southern California.

Arctostaphylos Manzanita Parry. (PLATE 15, FIG. 5.) Common manzanita.

Two specimens from different localities belong to *A. Manzanita* or one of the nominal species grouping with it. Discrimination cannot be made on the leaf parts alone.

A typical chaparral plant. Overlaps with *Sequoia* along the edge of the fog belt. Ranges from near the Oregon-California line east into the northern Sierra Nevadas and south to Mt. Tamalpais, California.

RUBIACEAE

Cephalanthus occidentalis Linnaeus. Button bush.

Several leaves, all of which show more numerous secondary veins than usual in this species.

Occurs along borders of lowland streams and ponds. Oregon and southeastern Canada to Mexico and Florida.

CONCLUSIONS

COMPARISON WITH OTHER FLORAS

The obvious feature in a comparison of this with other fossil floras is its very recent character. So far as the material might be identified every species is living in the Coast Ranges today. It is distinctly unlike the older Tertiary floras of the west, since their contents, palms, laurels, broad-leaved oaks, etc., are types indicating moist, nearly tropical conditions. The floras of the middle and upper Miocene are as yet largely undescribed.[15] From

[15] Lesquereux, L., Proc. U. S. Nat. Mus. 11: 35. 1889, has reported *Diospyros virginiana* L. var. *Turneri* Lesq., *Magnolia californica* Lesq., *Laurus* cf. *canariensis* Heer, *Viburnum* cf. *rugosus* Pers., and *Vitis* sp., and F. H. Knowlton in Turner, H. W., Jour. Geol. 6: 498. 1898, notes *Populus* sp., *Alnus* sp., *Castanea* sp., *Vaccinium* sp., and *Arbutus* sp. from Kirker's Pass near Mt. Diablo in the San Pablo

these some recent species may be expected and a comparison can then be made. However, the important changes in climate and humidity, which took place in the continental history of California at the opening of the Pliocene[16] have gone a long way toward eliminating these types. With their extinction appeared full-fledged and apparently unheralded, the modern California flora. It is obvious that the several peculiar genera and numerous species which characterize it could not have come into existence and become fixed types in the brief interval, geologically speaking, between the upper Miocene and late Pliocene. It is reasonable to assume that this flora, already developed to its present high specialization, immigrated from elsewhere, where, through a very considerable period of time, it had evolved.

The Santa Clara flora cannot be compared with other floras of corresponding age, since no other Pliocene floras have been described from North America.[17] Such floras occur in England[18] and other parts of Europe, but consist entirely of local species. Quaternary plants are known in the Loess of Canada[19] and the marine deposits of Maryland[20] but are likewise too remote to afford comparison.

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formation, Upper Miocene, associated with *Astropadsis Whitneyi* and other characteristic marine mollusca. No magnolias or chestnuts are now indigenous to California, and but few of the other species have any living relations west of the Rocky Mountains.

[16] While the stratigraphic relations of the Contra Costa and Kettleman Lake beds are known with considerable certainty, of the entire faunas, totaling some twenty species of fresh-water mollusks, only two, *Anodonta cygnea impura* and *Paludestrina longinqua*, are common to the two formations. These occur again in the Santa Clara beds and still exist, widespread, from southern Oregon east to the Rocky Mountains and south well into Mexico. The other Contra Costa species suggest strongly the fauna living in the lower Mississippi Valley. The Kettleman fauna on the other hand is the precursor of the existing central California fauna.

It seems probable that the abrupt change of conditions which eliminated the Miocene flora was coincident with that which eliminated the Miocene fresh-water mollusca. The latter took place during the comparatively brief interval separating the Contra Costa and Kettleman periods of sedimentation, and it is presumed the former did also.

[17] Knowlton, F. H., Jour. Geol. **18**: 116. 1910, has reported *Woodwardia* sp., *Sassafras* sp., and *Sterculia* sp. from the Falls of the Columbia River, in beds said to be of Pliocene age.

[18] Reid, C., & E. M. Jour. Linn. Soc. **38**: 206. 1908.

[19] Dawson and Penhallow. Bull. Geol. Soc. Am. **1**: 311. 1890.

[20] Hollick, A. Pliocene and Pleistocene. Md. Geol. Sur. **1906**: 148, 217.

All the species live today in the Coast Ranges of California north of San Francisco Bay. Indeed one familiar with the plants of that region would immediately identify this flora with that which inhabits the valleys of Sonoma, Mendocino, and Humboldt counties a few miles from the ocean in the zone of overlap of the redwood belt (Transitional zone) and chaparral belt (Upper Sonoran zone). That it does not show the extreme humid conditions of the open coast is evident from the presence of such species as *Alnus rhombifolia*, and species of *Cercocarpus* and *Arctostaphylos*. On the other hand *Sequoia* delineates it as at least partially fog belt in aspect.

EVIDENCE OF A COLD EPOCH

This flora agrees very well with the evidence of the aquatic mollusca and points to perceptibly colder conditions in central California during Pliocene time, but makes it certain that this cold facies was due not to elevation, but to actual migration of isotherms. Such a condition could not have been a local phenomenon but was probably widespread on the Pacific Coast.

This offers an explanation of the isolated occurrence of numerous arctic and boreal plants on the tops of high mountains far south of their normal distribution. The Santa Clara period was succeeded by the Sierran epoch, when the entire coast seems to have been carried by a great orogenic uplift many hundreds of feet above its present elevation. Very little is known of the climatic conditions which existed in California at that time. The rapid erosion prevented the formation of extensive lakes, and later depressions have carried all the marine deposits of the period even deeper beneath the ocean. This page, torn from the otherwise complete geologic record of the late Cenozoic of the coast, probably corresponds at least partially to the Glacial epoch elsewhere. Hence it is commonly assumed to have been colder and more humid than the present. It seems probable that the northern plants continued to exist south of their present southern limits during the early Quaternary, as a result of the cold epoch, the high elevation, the effects of which would be similar, or both, and were finally isolated toward the close of the Sierran epoch in the middle Quaternary.

ACKNOWLEDGMENTS

Acknowledgments are due first of all to Dr. J. P. Smith, at whose suggestion this study was undertaken, and whose interest and ever ready criticisms have made results possible. Dr. W. R. Dudley and Dr. LeRoy Abrams have permitted the free use of the Stanford University Herbarium, assisted in making identifications, and contributed everything in their power toward the writer's interest. Mr. James McMurphy, from his familiarity with the flora of the northern Coast Ranges, has also been of material assistance in the matter of determination of material. The plate is reproduced from photographs taken by Mr. John Howard Paine.

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Explanation of plate 15

(All figures are approximately natural size.)

FIG. 1. *Arbutus Menziesii* Pursh, Portola.
2. *Quercus chrysolepis* Lieb., Calabazas Cañon.
3. *Sequoia sempervirens* (Lamb.) Endl., Portola.
4. *Cornus glabrata* Benth., Calabazas Cañon.
5. *Arctostaphylos Manzanita* Parry, Calabazas Cañon.
6. *Alnus rhombifolia* Nutt., Solly Ranch.
7. *Rhamnus californica* Esch., Calabazas Cañon.
8. *Pasania densiflora* (Hook. & Arn.) Oerst., Portola.
9. *Quercus chrysolepis* Lieb. (inside cast of acorn cup), Portola.
10. *Rhamnus Purshiana* DC., Portola.

A supplemental description of Euphorbia ephedromorpha

H. H. Bartlett

The original description of *Euphorbia ephedromorpha* was drawn up from flowering specimens collected by Mr. C. C. Deam, in January, 1905, near Gualan, Guatemala. Mr. Deam has since supplemented the type material by specimens collected in June, 1909, at the original locality. The specimens collected in January have no leaves (FIG. 1); those collected in June are in full leaf (FIG. 2) but show no trace of the caducous cymes. With the ample material of this anomalous plant, which is now available, it is possible to supplement the incomplete original diagnosis and to correct certain serious misconceptions regarding its relationship and morphology. *Euphorbia ephedromorpha* is not, as formerly stated to be, a member of the section Alectoroctonum. It cannot be placed in any of the sections defined by Boissier in de Candolle's Prodromus, and so far as a careful search of the literature has shown, no species related to it have been described. A new section, Ephedromorpha, is proposed for its reception, to be ranged with the five of Boissier's sections of *Euphorbiae appendiculatae* which are characterized by the presence of stipular glands.

Euphorbia§ Ephedromorpha sect. nov.

Shrubs with winged stems. Leaves ample, deciduous, alternate, with two minute stipular glands at the base of the pet ole on either side of the flower bud. Cymes compound (i. e., main axis arrested by a cyme, not by a single involucre); bracts filiform-spatulate, opposite, only one of each pair bearing an axillary branch. Involucral glands plane, ovate, with entire appendages. Seeds foveolate.

Species two, Central American and Mexican. (The second species, represented in the Gray Herbarium by fragments too poor to serve as a type, was collected at Cerro Quiengola, Oaxaca, Mexico, *Caec. & Ed. Seler 1611*.)

Euphorbia ephedromorpha Bartlett, Proc. Am. Acad. 43: 56. 1907.

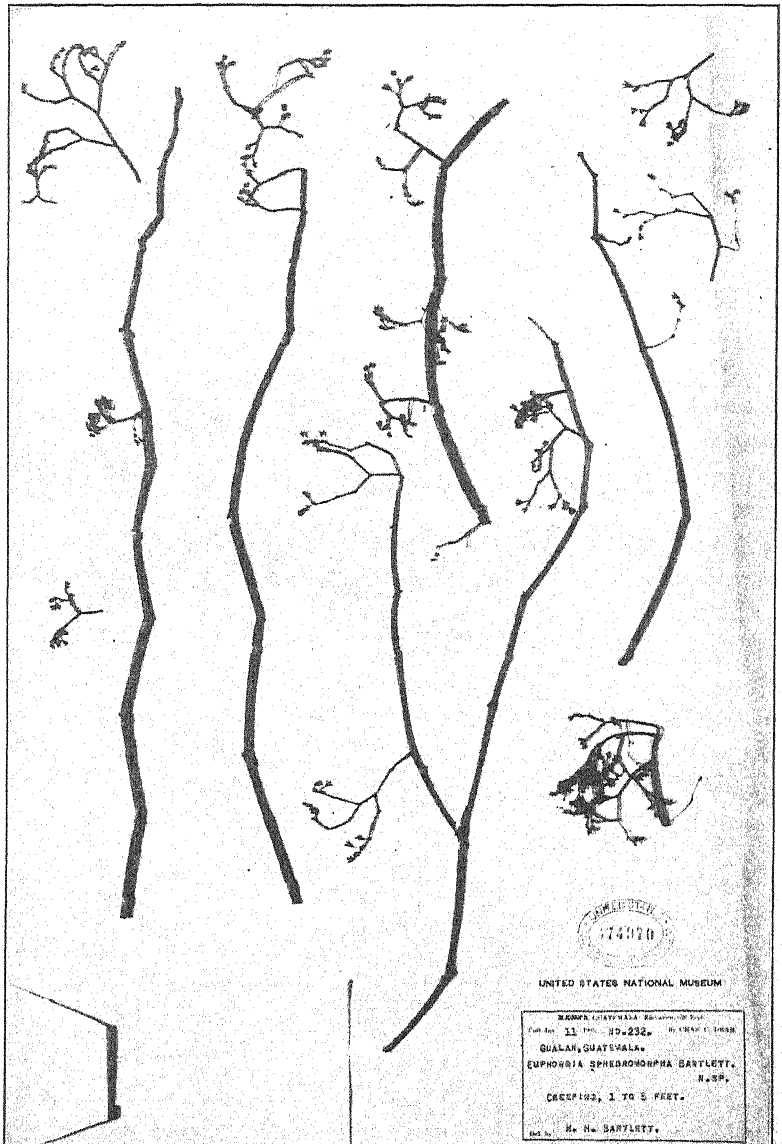

FIG. 1. *Euphorbia ephedromorpha*, in flower, × 1/3.

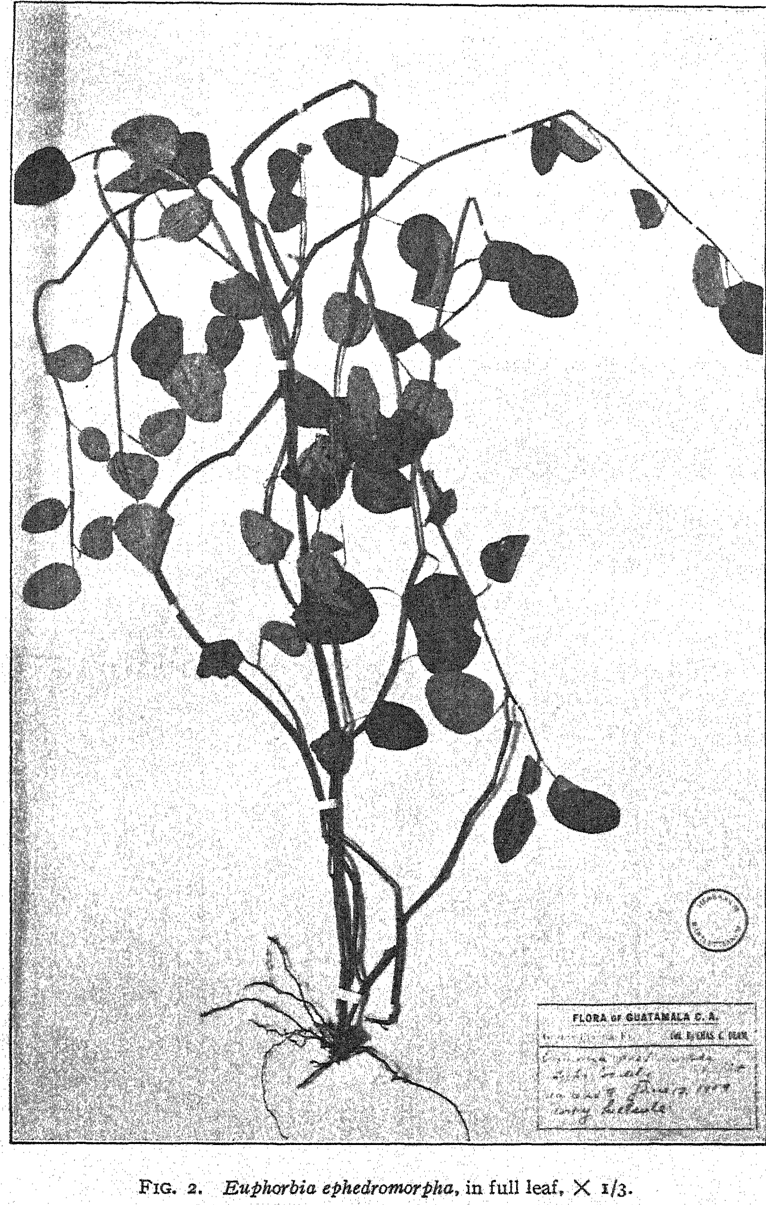

FIG. 2. *Euphorbia ephedromorpha*, in full leaf, × 1/3.

Shrub; branches prostrate or ascending, a meter long, sparsely branched, wing-angled, glabrous, green; leaves deciduous, ovate, somewhat pilose, especially on the veins beneath, blades 2–4.5 cm. in length, petioles half as long; stipular glands minute, on either side of the flower bud at the base of the petiole; cymes axillary on the old wood, expanding before the leaves, densely glandular-pilose, as are also the minute filiform-spatulate bracts; involucres narrowly conic, 3 mm. long, equaling their pedicels, segments five, very short, flabelliform, digitately laciniate, glands five, bearing oblong or slightly spatulate, entire, white appendages (FIG. 3); ovary 2 mm. long in fruit, slightly exserted from the involucre; seeds lilac gray, ovoid, foveolate.

In nude rocky dry soil at the side of a road leading from Gualan to the Motagua River, Department of Zacapa, Guatemala, *C. C. Deam 232* (in flower, 11 Jan. 1905) and *6529* (in full leaf, 14

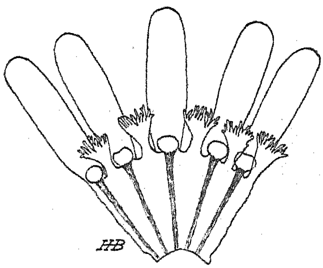

FIG. 3. Involucre of *Euphorbia ephedromorpha*, × 10.

June 1909). On leafless branches of *Euphorbia ephedromorpha* the stipular glands are quite obliterated at the edge of the depressed scar of the caducous cyme.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1907–1911

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Includes descriptions and illustrations of *Omphalia Volkertii, Inocybe Lorillardiana, I. Astoriana, I. abundans,* and *Campanularius semiglobatus* spp. nov.

Fig. 10.

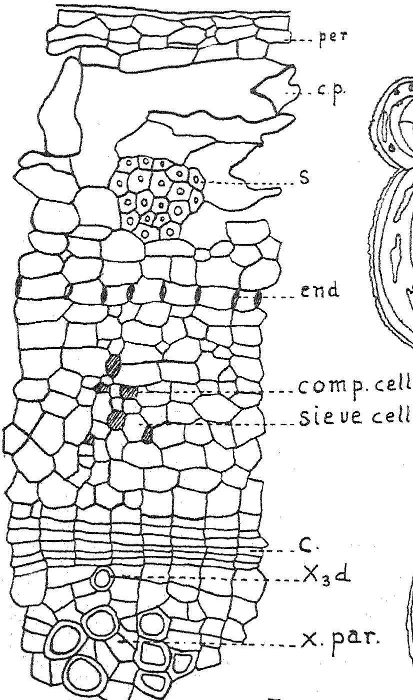


Fig. 6.

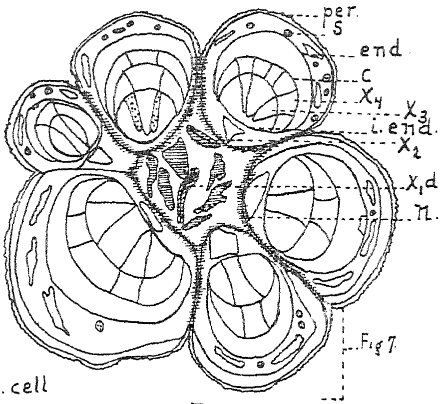


Fig. 5.

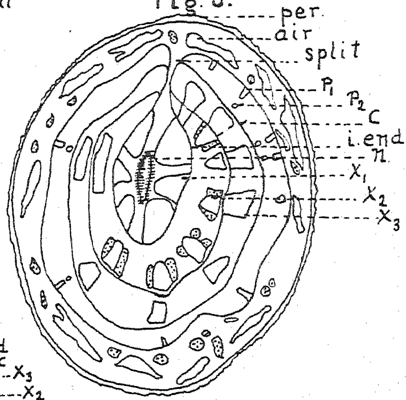
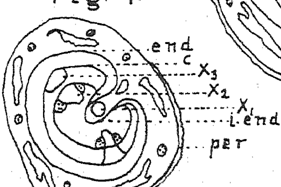


Fig. 9.



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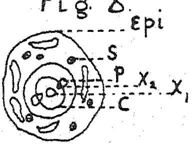


Fig. 3.

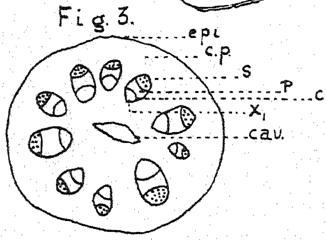
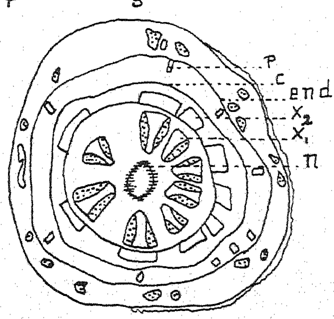


Fig. 4.



M.A.K. del. ad nat.

KINGSLEY, RHIZOME AND ROOT OF DELPHINIUM SCAPOSUM

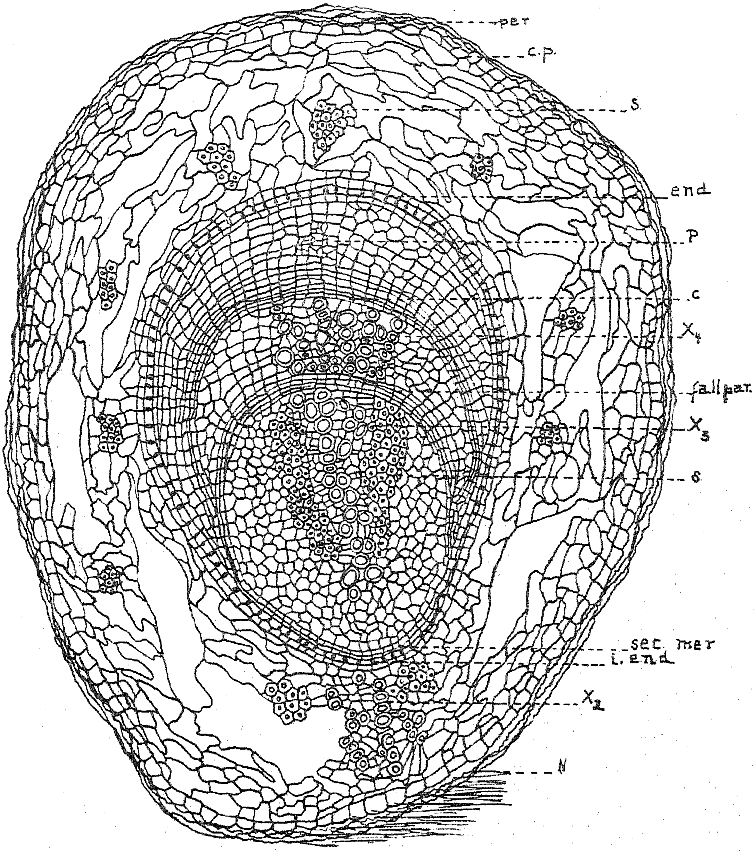
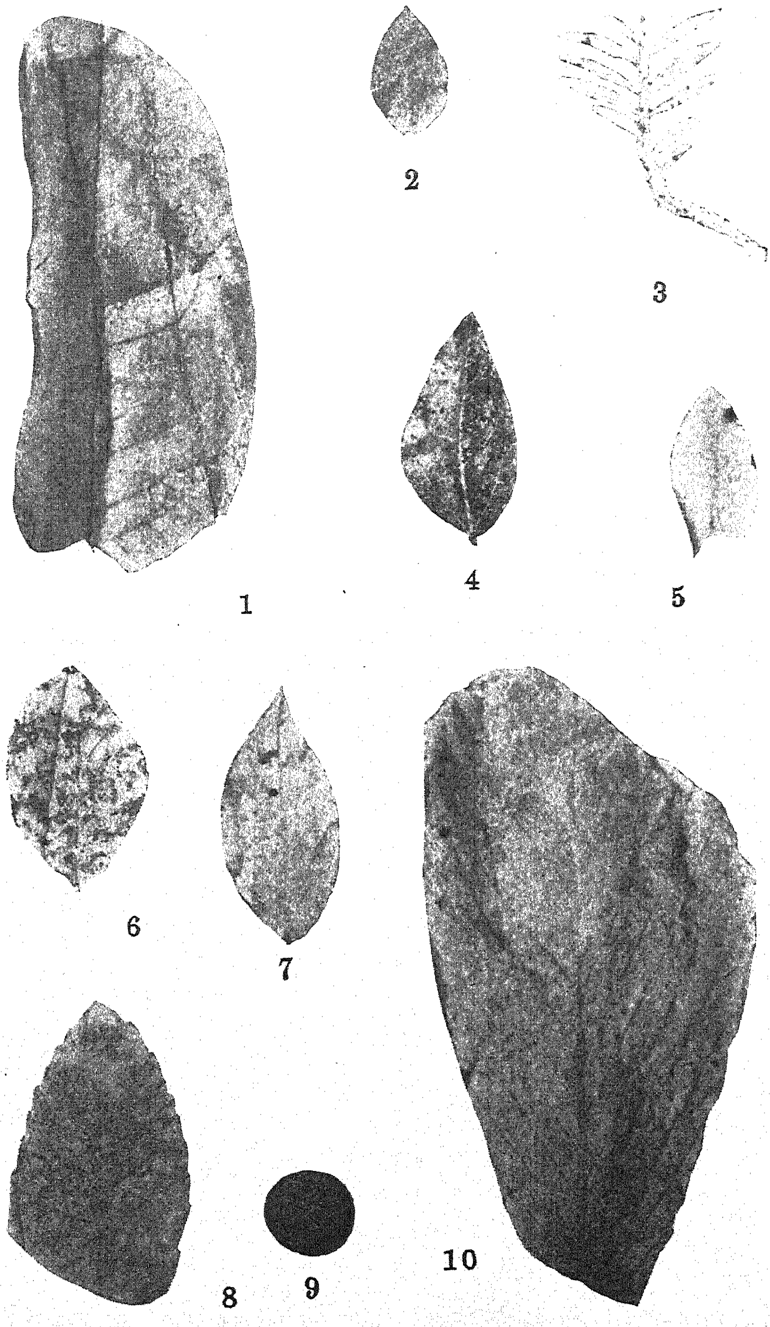


Fig. 7.

M.A.K. del ad nat.

KINGSLEY, RHIZOME OF DELPHINIUM SCAPOSUM



HANNIBAL, PLIOCENE FLORA

Vol. 38 No. 7

BULLETIN

OF THE

TORREY BOTANICAL CLUB

AUGUST, 1911

Notes on Rosaceae—VI

PER AXEL RYDBERG

ARGENTINA

In an article in Rhodora for January 1909, Prof. M. L. Fernald discussed "The Representatives of *Potentilla Anserina* in Eastern America." The second paragraph of his article reads as follows: "In November, 1908, two extensive monographs of *Potentilla* appeared, but when one turns to these two treatments with the hope of settling his long-standing problems the results are certainly disheartening." And then, "after spending *some days** in the study of the material in the *Gray Herbarium* and the Herbarium of the *New England Botanical Club*," he solves the problems. Fifteen years have now passed since I began my work on *Potentilla* and Dr. Th. Wolf has devoted longer time than that to the study, and neither of us has definitely settled the status of the different forms of this group. When the manuscript of my monograph in the North American Flora went to press I had seen not only the collection in the Gray Herbarium but also those of the New York Botanical Garden, Columbia University, United States National Herbarium, Philadelphia Academy, and the College of Pharmacy, New York. When preparing my original monograph, printed in 1898, I had also seen the collection of the Missouri Botanical Garden. Besides, many of the critical species had been sent to me for determination by the University of California, Mr. T. S. Brandegee, Mr. Parish, and many others.

* Italics are mine.

[The BULLETIN for July 1911 (38: 307–350. *pl. 13–15*) was issued 27 Jl 1911.]

In the Gray's New Manual, published September 18, 1908, the authors, Robinson and Fernald, stated under *Potentilla Anserina* as follows: "Var. *grandis* T. & G. is merely a luxuriant state in rich meadows." It is strange that so shortly after, in January, 1909, Professor Fernald should admit this variety as a good species. The difference in the achenes, pointed out by me, evidently persuaded him that it could not be kept in *Potentilla Anserina* L. (*Argentina Anserina* Rydb.). It would have been asking too much if one expected him to admit all at once the eight species recognized in my monograph. My intention is not to defend them as species. The limitation between species and variety will always be arbitrary, so also between variety and form. If Professor Fernald admitted *Argentina argentea* as a variety under the name *Potentilla Anserina* var. *sericea*, he should have admitted *A. occidentalis*, *A. litoralis*, and *A. subarctica* also as varieties. There are certain statements, also, in Fernald's article, to which I must take exception. As Professor Fernald has admitted *Argentina argentea* Rydb. as a variety I should feel content so far as this species is concerned, but I can not pass it altogether. The specimen in the Gray Herbarium from St. John Valley, referred to in Professor Fernald's paper is "in spite of its leaves being silvery on both sides," not *A. argentea*. I remember the specimen very well. Neither is *A. argentea* exactly the same as *Potentilla Anserina sericea* Hayne. Both have leaves silvery on both sides, but in the Rocky Mountain plant the leaflets as a rule are decidedly obovate, with comparatively few ovate teeth, while in the Eurpoean plant the leaflets are usually much longer, elliptic, and with numerous lanceolate teeth directed forward. I have not seen any specimens of *Argentina argentea* east of South Dakota. It needs therefore not to be considered in connection with the flora of eastern North America.

In discussing the species with nongrooved achenes, Professor Fernald criticizes my key, in which I separate *P. pacifica* and *P. occidentalis* from the rest by the petals being "usually over 1 cm. long rounded-obovate," while the others have petals "6–8 mm., rarely 1 cm. long, usually elliptic-obovate." It may be true that I have "never known the full beauty of its large flowers" [*A. litoralis*] and that the given characters do not hold. I did not see the speci-

mens in the herbarium of the New England Botanical Club, although I saw all in the Gray Herbarium. I have never seen any one, however, with such broad rounded petals as are usual in *A. occidentalis*. The latter has usually also broader and more obovate leaflets. Even if *A. occidentalis* and *A. litoralis* should be one species or variety, as you please, and the characters assigned should be found inconstant, the name of the eastern plant should not be *Potentilla pacifica* Howell, for that species was based on *P. Anserina β grandis* T. & G. The type was collected by Scouler and a fair duplicate is in the Torrey Herbarium. If I have not known the eastern plant "in its full beauty," I doubt if Professor Fernald has seen *Potentilla pacifica* in its. At least he did not see it in the Gray Herbarium, for if I remember rightly there was but one fair specimen of it there, shortly before my manuscript went to press.

The first synonym given under *Potentilla pacifica* by Professor Fernald is *P. Anserina groenlandica* Tratt. The type of the latter, collected by Giesecke, I have not seen, but Trattinick's description points evidently to the form of *P. Egedii* Wormskj. with the leaves whitened beneath. Notwithstanding the fact that Dr. Wolf limits *P. Anserina Egedii* to the glabrous form the fact remains that in *Argentina Egedii* (Wormskj.) Rydb. the leaves are whitened beneath or not, even in the same plant. Evidently Dr. Wolf includes in his var. *groenlandica* also the arctic plant from Alaska, which I described as *A. subarctica*. This Professor Fernald reduced to a synonym of *Potentilla pacifica*. Placing the duplicate of the types of *Argentina pacifica*, collected by Scouler, and the type sheet of *A. subarctica* collected by Dr. A. Hollick side by side, few persons would regard them as the same species or at least not as the same variety. *P. subarctica* is characterized by its decidedly turbinate hypanthium and few achenes, characters found only in this species and *Argentina Babcockiana*. In all the others the hypanthium is almost flat. The petals are rarely over 8 mm. long, while in *A. pacifica* they are usually 12–15 mm. long. In the latter the leaves are almost erect while in the other species they are spreading, except when growing among tall grass.

Dr. Wolf's treatment in including all the forms belonging to

this genus in but one species, even if he admits several varieties, is unsatisfactory. He even makes the very distinct *P. anserinoides* a variety of *Potentilla Anserina*. My treatment is not satisfactory to Professor Fernald and to several other North American botanists, being too radical; but Professor Fernald, who has tried a kind of compromise, will not be followed by all. There is no doubt but that he knows the New England species better than anyone else, but the name *Potentilla pacifica* Howell does not belong to the eastern plant, and *Argentina subarctica* is not a synonym of it. If he had treated them as varieties I would have been satisfied, for what he and many others call varieties, I call species.

Argentina Anserina (L.) Rydb. and *A. argentea* are represented by numerous specimens in our herbaria. The others are less well represented. In the herbaria of the New York Botanical Garden and Columbia University are found the following. The lists I had from the U. S. Nat. Herbarium and the Gray Herbarium I have mislaid and can not find.

ARGENTINA PACIFICA (Howell) Rydb.

OREGON: Beach, Nestucca, 1901, *Kirkwood 129;* locality not given, *Scouler.*

WASHINGTON: Chehalis County, 1897, *Lamb 1080.*

BRITISH COLUMBIA: Vancouver Island, *Boas.*

ARGENTINA OCCIDENTALIS Rydb.

CALIFORNIA: Suisun, Solano County, June 6, 1903, *Baker 3217;* Albion, Mendocino County, May 1903, *McMurphy 263;* Mendocino County, May 1898, *H. E. Brown 723;* San Mateo County, May 1877, *H. Edwards;* Pacific Grove, April 1903, *Heller 6632;* Lake Merced, San Mateo County, April 1907, *Heller 8441;* Colima, March 1877, *H. Edwards.*

OREGON: Netarts Bay, June 1894, *F. E. Lloyd.*

WASHINGTON: Granville, July 1902, *Conard 349;* Clallam County, June 1900, *Elmer 2525;* Olga, July 8, 1905, *Engberg.*

BRITISH COLUMBIA: Chase River, Vancouver Island, May 1887, *J. Macoun;* Renfrew, 1901, *Rosendahl & Brand 5;* Queen Charlotte Island, 1901, *Boas 28.*

ALASKA: Yes Bay, June 30, 1895, *Gorman 61½*.

It has been collected also on Behring Island, 1891, *Grebritsky*.

ARGENTINA LITORALIS Rydb.

ST. PIERRE: July 14, 1900, *Arsène*.

NEWFOUNDLAND: Channel, July 27, 1901, *Howe & Lang 785;* Barred Island, 1903, *Sornborger;* Placentia, 1894, *Robinson & Schrenk 42*.

LABRADOR: 1894, *Waghorne;* Nain, 1897, *Sornborger 27*.

NOVA SCOTIA: Mabou, August 1906, *C. B. Robinson 247;* Yarmouth, June 1901, *Howe & Lang 1*.

QUEBEC: Seven Islands, August 1907, *C. B. Robinson 689;* Lake Témiscouata, 1887, *Northrop 117*.

MAINE: Gross Island, Maine Coast, 1893, *Harvey;* Seal Harbor, Aug. 20, 1891, *T. G. White*.

MASSACHUSETTS: West Tisbury, August 1895, *Burgess;* East Medford, June 1878, *Perkins;* Ipswich, *Oakes;* Ipswich, June 1874, *Morong*.

NEW HAMPSHIRE: Sumner Falls, Plainfield, July 1900, *Eggleston 1977*.

RHODE ISLAND: Warwick, *Olney*.

ARGENTINA BABCOCKIANA Rydb.

NEW YORK: Westminster Park, 1910, *Miss E. Babcock;* shores of Oneida Lake June 1896, *Mason*.

ARGENTINA SUBARCTICA Rydb.

NORTH WEST TERRITORY, CANADA: 1861–2, *Onion, Kennicott & Hardisty*.

BRITISH COLUMBIA: Macleod Lake, 1879, *Dawson 7221*.

YUKON: Fort Selkirk, July 18, 1899, *Tarleton 132;* Dawson, July 1899, *R. S. Williams*.

ALASKA: Yukon River near Palisades, July 14, 1903, *Hollick;* Yakutat Bay, 1892, *Funston 34*.

The following are referred here doubtfully:

IDAHO: Sand Point, Aug. 24, 1901, *Umbach 428;* Lake Pend d'Oreille, near Hope, 1892, *Sandberg, MacDougal & Heller 937*.

MONTANA: Midvale, June 1903, *Umbach 217*.

ARGENTINA EGEDII (Wormskj.) Rydb.

HUDSON BAY REGION: Cape Jones, 1899, *A. P. Low 63182.*

LABRADOR: Rama, 1899, *Stecker 368.*

GREENLAND: Disco, 1902, *M. P. Porsild 921;* Kuanersuit *1448;* Fiskernaeset, *Holboell.*

ICELAND: Mura, 1888, *C. Sprague Smith.*

COMARUM

As I have stated in a previous paper, Dr. Wolf erroneously referred *Comarum palustre* L. or *Potentilla palustris* Scop. to the section POTENTILLAE TRICHOCARPAE, subsection NEMATOSTYLAE, series SUFFRUTICULOSAE. The ovaries and carpels are perfectly glabrous and the stem is in no way shrubby, the only perennial part being the horizontal creeping rootstock. Furthermore Dr. Wolf has associated with it *Potentilla Salesoviana* Steph. This is a shrubby plant with hairy ovaries and carpels. The only character that would bring them together is the color of the petals, which are purple or rose colored. In every respect *P. Salesoviana* is more closely related to *Dasiphora* than to *Comarum*. It has the shrubby habit of *Dasiphora*, the pinnate leaves, the scarious, sheathing stipules, the flattened anthers, subcordate at the base and dehiscent on the margins, practically the same arrangement of the stamens, and the woolly achenes of that genus. The only characters in which it does not agree with *Dasiphora* are found in the styles and stigmas and the color of the petals. The style is filiform, not clubshaped, and the stigma acutish and obsolete, not expanded, and bluntly 4-lobed, and the color of the flowers is rose or whitish, not yellow. As the color has no value as a generic character, the characters of the style and stigma are the only characters that would keep it out of *Dasiphora*. It should be included in this genus or else be made a distinct genus. The position of the style is lateral in both *Dasiphora* and *Comarum*. *Potentilla Salesoviana* differs from *Comarum*, not only in the characters given above, viz., the shrubby habit and the hairy carpels, but also in the form of the anthers and arrangement of the stamens.

The form of *Comarum palustre* common in North America differs considerably from the typical form of northern Europe.

It is usually much taller and the leaflets are linear-oblong, 5–8 cm. long and only 1–2 cm. wide, obtuse or rounded at the apex and with lanceolate teeth. It was described as *Comarum angustifolium* by Rafinesque. In the European form the leaflets are elliptic or oval, mostly acute at both ends, with broad and ovate teeth. This is also the prevailing form in arctic and subarctic America, but the two forms grade in numerous ways into each other, and *C. angustifolium* can be regarded scarcely more than a variety. So also *C. tomentosum* Raf. (*Potentilla palustris villosa* Lehm.). All grades of pubescence occur from a dense and subvelutinous one to practically none.

DUCHESNEA

Dr. Wolf included *Duchesnea indica* (Andrews) Focke in *Potentilla* and associated it with *P. reptans*, *P. canadensis*, etc. With Dr. Wolf's broad view of genera this was very natural, but I can not see how he could keep out *Sibbaldia* and even *Fragaria* from his *Potentilla*. All three have lateral styles, and *Sibbaldia* is even habitually as close to the typical *Potentillae* as *Duchesnea* is.

FRAGARIA

It is exceedingly hard to draw specific lines in this genus. It is easy to distinguish *F. vesca* or *F. americana* from *F. virginiana* or *F. grandiflora*, for in the former two the achenes are wholly superficial, while in the latter two they are set in deep pits in the fleshy receptacle, but such species as *F. californica* and *F. mexicana* connect the two groups, the achenes being in very shallow pits.

A twelve years' study of the genus since the publication of my Monograph of the North American Potentilleae, had not changed my views, and the recognized species remained practically the same in my new revision in the North American Flora, only that three new species were described, two varieties given specific rank, and *F. multicipita* Fernald and the introduced *F. grandiflora* Ehrh. added. The treatment in my monograph was not followed either by the authors of the Gray's New Manual or by those of the New Manual of the Central Rocky Mountains; and I scarcely expected that it would. The former admits only two species and two varieties as growing in the northeastern United States, while

my monograph admitted five species and one variety, and my treatment in the North American Flora admits seven species. *Fragaria canadensis* and *F. Terrae-novae* are both reduced to forms of *F. virginiana*. Concerning *F. canadensis* the following remarks are found: "A form with the pubescence generally more sparing, the hairs on the scape being subappressed, is sometimes distinguished. (*F. canadensis* Michx., in part.)" The first one who in later years took up the name *F. canadensis* Michx. was Dr. N. L. Britton. He was followed by myself. I do not know of anybody else who in print has "distinguished" *F. canadensis* from *F. virginiana*, i. e., pointed out the differences between the two. The plant characterized by us is not a plant with appressed or subappressed pubescence on the scape but one with spreading pubescence. The distinguishing characters given by us are the oblong-conic fruit and the narrower leaflets with shorter petiolules. It is a rare plant and could be a hybrid between *F. virginiana* and *F. americana*, but the well-developed fruit, which is even longer and narrower than in *F. americana*, speaks against it. Besides, Professor Fernald has collected in the lower part of Quebec an entirely different plant, which looks much more like a hybrid between those two species. This plant is intermediate between the two but more like *F. americana* and is apparently sterile, a fact that speaks for a hybrid origin. In the Gray's New Manual the following remark is also found: "Another scarcely separable form has the hairs on both scapes and petioles sparse and subappressed. (*F. terrae-novae* Rydb.)" These characters are true but they are not the only ones. *F. Terrae-novae* has the large flowers of the western *F. platypetala*, the petals being almost twice the length of the sepals, while in *F. virginiana* they are usually about half longer than the sepals. *F. Terrae-novae* is about as distinct from *F. virginiana* as is Fernald's own *F. multicipita*. The difference between *F. Terrae-novae* and *F. multicipita* is that in the former the leaflets are short-petioluled while in the latter they are sessile. The petals of *F. multicipita* are unknown. *F. Grayana* and *F. americana* are regarded as varieties of *F. virginiana* and *F. vesca* respectively. So they were regarded by Dr. S. Watson.

The treatment in the New Manual of the Central Rocky Mountains is rather less satisfactory. *Fragaria bracteata* Heller

is made a synonym of *F. americana*. The two resemble each other much in habit, but in the former the sepals in fruit are ascending or merely spreading, while in the latter they are reflexed as in the European *F. vesca*. It would have been better to reduce *F. americana* to a synonym of *F. vesca*. *Fragaria prolifica*, *F. pumila*, and *F. firma* are given as synonyms under *F. ovalis*. *F. firma* is a pure synonym, for when I described it I had no idea that the strawberry collected by Fendler under the number 206 was the type of *Potentilla ovalis* Lehm. Neither *F. prolifica* nor *F. pumila* are glaucous, but bright green. Professor A. Nelson has placed *F. ovalis*, and consequently also these two species in his division "Leaves somewhat glaucous, pubescence of scape and petioles appressed." He placed *F. platypetala* in the division "Leaves not glaucous; pubescence of the scape spreading or reflexed," although that species usually is decidedly glaucous. *F. glauca* is made a variety of *F. ovalis* although its leaves are by no means "thick." Watson's type has thinner leaves than the type of *F. pauciflora* Rydb., which is regarded as distinct. If *F. glauca* had been made a variety of *F. pauciflora* or vice versa, I would not have made any criticism.

The new species proposed in the North American Flora are *Fragaria insularis*, *F. Suksdorfii*, and *F. yukonensis*. *F. insularis* was based on material from Jamaica, supposed to be *F. vesca* introduced, but the plant is much more glaucous and less hairy than the northern European plant, and the sepals in fruit are not reflexed but ascending or spreading. The plant may be an introduced one in Jamaica, but the same plant has been collected in the Azores and Madeira. It may be the same as the *F. vesca* reported from Spain, but of this I am uncertain as I have seen no Spanish material. Lowe in his flora of Madeira* mentions a wild strawberry with the sepals enclosing the fruit. This may have been *F. insularis*.

In our herbaria are found the following specimens of *F. insularis:*

JAMAICA: Bank, Hardware Gap, 1908, *N. L. Britton 1778* and *3324;* Cinchona ("Wild strawberry"), 1906, *Wm. Harris 9216;* vicinity of Cinchona, 1908, *Alexandrina Taylor 4230* (in part);

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*Man. Fl. Madeira 1: 246. 1868.

same locality, 1906, *N. L. Britton 139;* same locality, 1900, *W. N. Clute 228.*

AZORES: Fayal, 1894, *C. S. Brown 77.*

Fragaria Suksdorfii was based on material which I had referred previously to *F. cuneifolia*, but the broadly lanceolate sepals and the decidedly villous fruit distinguish it from that species. The following specimens belong here:

WASHINGTON: Falcon Valley, June 2 and 28, 1883, *Suksdorf 486.*

OREGON: *Wilkes Expedition 440.*

BRITISH COLUMBIA: Meyers Creek, May 5, 1905, *Spreadborough 69948*, is referred here with some doubt, as there is no fruit.

Fragaria yukonensis was described from material originally determined as *F. chiloensis* or *F. glauca*. The type and some other specimens were referred to *F. chiloensis* on account of the thick subcoriaceous leaflets, but the latter lack the fine tomentum mixed with the longer hairs on the lower surface, characteristic of those of *F. chiloensis*. *F. yukonensis* could not be referred to *F. glauca* on account of its thick leaves. In fact it is more closely related to the southern *F. ovalis* which it resembles very closely. It differs, however, in the distinctly petiolulate instead of subsessile leaflets and in the longer bractlets. Besides, *F. yukonensis* is not known outside of the Yukon Territory, and *F. ovalis* not north of Wyoming. The following specimens belong to the former:

YUKON TERRITORY: Lake Lebarge, June 19, 1899, *Tarleton 38;* Rapid City, Aug. 20, 1899, *R. S. Williams;* Ranch Creek, June 8, 1899, *Gorman 1009;* Fifty Miles River, 1899, *A. L. Bolton.*

Fragaria Grayana Vilmorin was restored to specific rank in the North American Flora. It was first described as *F. virginiana illinoensis* A. Gray, under which name it has been best known. It was recognized before Dr. Gray described it, by Price, who recorded it as *F. illinoensis* but gave no description. I have found no specimens in the herbaria from any place east of Indiana and Alabama, although the type was said to have come from western New York. All specimens so named from the eastern states belonged to either *F. virginiana* or *F. grandiflora*, which latter is an escape from cultivation.

Fragaria grandiflora Ehrh., the "pine strawberry," is a native of South America. It is often hard to distinguish it from *F. Grayana*, but the petals are larger, usually over 1 cm. long, the sepals ovate or ovate-lanceolate, the achenes set in shallower pits, and the leaflets thicker. It often resembles closely *F. chiloensis* but lacks the characteristic tomentum of the lower surface of the leaflets. In cultivation are found many crosses between this species and *F. chiloensis* and *F. virginiana*. In the New York Botanical Garden herbarium there are the following specimens of *F. grandiflora*, which were collected far away from dwellings and which were well established at the localities:

NEW YORK: Roadside in woods between Twin Lakes and Mountain Lodge, Adirondack Mountains, July 4, 1906, *Rydberg 7842*.

BRITISH COLUMBIA: Trail, May 19 and June 13, 1902, *J. M. Macoun 63776* and *63777*.

KENTUCKY: Vicinity of Mammoth Cave, May 1899, *Dr. E. Palmer*.

At the same station where the writer collected *F. grandiflora*, he found also the white-fruited *F. vesca*, and the ordinary *F. virginiana*, with a white-fruited form of the latter. The white-fruited *F. vesca* is not uncommon in certain localities from northern New York and Connecticut to West Virginia and eastern Ohio. It is most common in the mountains of Pennsylvania. It is strange that this form should be common and apparently native in a region where the typical *F. vesca* is very rare and is found apparently only as an escape from cultivation. It is questionable if it should not be regarded as a native geographical species even if it originally mutated from *F. vesca*. It is not a form of the native *F. americana*.

The white-fruited form of *F. virginiana* collected in the Adirondacks by the writer and mentioned above, is very interesting. As the white-fruited *F. vesca* and the ordinary red-fruited *F. virginiana* were common along the road and growing together, these white-fruited specimens of *F. virginiana* might be hybrids between the two. They were typical *F. virginiana*, however, in every respect, even to the pitted fruit, except that the latter was white.

SIBBALDIA, SIBBALDIOPSIS, AND DASIPHORA

No essential change has been made in the treatment of these genera since the publication of my monograph of 1898.

DRYMOCALLIS

This genus is exceedingly perplexing as to its numerous and somewhat intergrading forms. It is by no means easy to draw specific lines. As represented in the eastern United States it is easily disposed of, as it is there represented by only one species, *D. agrimonioides* (*Potentilla arguta* Pursh). In the Rocky Mountain region there are at least nine forms which I have regarded as species, and these increase to about two dozen in the Pacific States. In the North American Flora there were admitted in all 28 species. Of these the following were proposed as new: *Drymocallis corymbosa*, *D. foliosa*, *D. pumila*, *D. viscosa*, *D. arizonica*, *D. amplifolia*, *D. oregana*, *D. laxiflora*, *D. albida*, and *D. micropetala*. Besides these, *D. glandulosa monticola* and *D. glandulosa incisa* were raised to specific rank and the name *D. agrimonioides* (Pursh) Rydb. was substituted for *D. arguta* (Pursh) Rydb., as *Geum agrimonioides* both has page priority and was based on the typical form.

Drymocallis corymbosa was described from specimens included in *D. convallaria* in my Flora of Montana. It differs from the original *D. convallaria* in the flat-topped instead of racemiform cyme, the rounded-obovate instead of rhombic-obovate leaflets, and the conspicuously long-hairy stem and petioles.

It is common from Alberta to Colorado, Idaho, Washington, and British Columbia.

Drymocallis foliosa was described from specimens which I had formerly determined doubtfully as *D. glutinosa* Rydb., i. e., *D. valida* (Greene) Piper. It is characterized by its large-leaved inflorescence and its rhombic-obovate coarsely and incisedly toothed leaflets. The following specimens belong to it:

MONTANA: Bridger Mountains, 1896, *Flodman 596*.

WYOMING: Buffalo Fork, 1897, *Tweedy 214;* Encampment, 1901, *Tweedy 4148*.

UTAH: Alta Mountains, 1899, *M. E. Jones 1108*.

Drymocallis pumila was based on some specimens included in *D. rhomboidea* in my monograph of 1898, and some material received later. Although it resembles *D. rhomboidea* in habit, it differs, however, in one essential character, viz., in the styles, which are decidedly fusiform. In *D. rhomboidea* as well as in *D. glabrata* the styles are filiform. Dr. Wolf remarks under *Potentilla rhomboidea* that he has found in "typical and fine specimens" of this species collected by Suksdorf (*no. 742*) the styles to be fusiform. This number of Suksdorf's, as seen below, belongs to *D. pumila* instead. The large flowers would place it near *D. fissa*, but it is a much more delicate plant, the stem leaves are much reduced and the bractlets are elliptic or oval instead of lanceolate or linear. The following specimens belong here:

OREGON: Stein's Mountains, 1901, *Cusick 2571;* same locality, 1901, *Griffiths & Morris 576*, and 1896, *J. B. Leiberg 2508.*

WASHINGTON: Mount Paddo, 1885, *Suksdorf 742.*

NEVADA: Summit Lake, 1901, *Griffiths & Morris 311.*

UTAH: Marysvale, 1894, *M. E. Jones 5375n.*

Drymocallis viscosa resembles much *D. glandulosa* in habit, has the large petals of *D. valida* and *D. fissa* and the bractlets of *D. pumila*, but differs from all in the conspicuous viscidity of the plant. It is known from the type locality only.

Drymocallis arizonica Rydb. resembles closely *D. Hanseni* but differs in the short dense inflorescence and the longer bractlets. It might have been included in that species but it grows in an entirely different region. The following specimens belong to it:

ARIZONA: Mormon Lake, 1898, *MacDougal 64;* Bill Williams Mountains, 1883, *Rusby 137* and *594.*

UTAH: Near St. George, 1877, *Palmer 146.*

Drymocallis amplifolia connects the *D. glandulosa* group with that of *D. Wrangelliana.* It has the habit of the former and the small pale petals of the latter. It is characterized by its large rhombic terminal leaflets, which resemble somewhat those of *D. foliosa.* The latter has very large deep yellow petals. *D. amplifolia* is known from the type station only, from which several specimens have been seen.

Drymocallis oregana was based partly on material included in *D. Wrangelliana* in my monograph and partly on material studied

later. The type was collected by Thomas Nuttall and labeled by him *Potentilla oregana*. This name is cited in Torrey and Gray's Flora as a synonym under *P. glandulosa*. It is, however, more closely related to *D. Wrangelliana*, having the same oval sepals, rounded and mucronulate at the apex, and the small petals of the species; but the pedicels are longer, those of the earlier flowers 1–2 cm. long, the infloresence less leafy, and the petals pure yellow instead of ochroleucous. The stem is also usually more conspicuously long-hairy. It is of more northern distribution, ranging from the Mackenzie and British Columbia to Idaho and Oregon, while *D. Wrangelliana* is confined to California. The following specimens belong here:

OREGON: Columbia River, *Nuttall;* near Wimer, 1893, *Hammond 114 A;* base of Mt. Hood, 1894, *F. E. Lloyd;* eastern Oregon, 1898, *Cusick 2159;* Juniper Springs, 1896, *Leiberg 2286.*

IDAHO: About Lewiston, May 27, 1896, *A. A. & E. Gertrude Heller 3130;* valley of Big Potlatch River, June 6, 1892, *Sandberg, MacDougal & Heller 316;* Moscow Mountains, May 30, 1900, *Abrams 663.*

WASHINGTON: Olympic Mountains, August 1895, *Piper 2000;* Wenatchee, May 25, 1899, *Whited 1095.*

BRITISH COLUMBIA: Between Kettle and Columbia rivers, July 19, 1902, *J. M. Macoun 34527, 63786,* and *63787;* Skagit Valley, June 23, 1905, *J. M. Macoun 69938;* Chilliwack Lake, 1901, *J. M. Macoun 34440.*

NORTH WEST TERRITORY: *Franklin.*

When preparing the manuscript of my monograph in 1896, I studied several specimens labeled *Potentilla reflexa* Greene. Thinking these specimens authentic I drew my description of *Drymocallis reflexa* (Greene) Rydb. mainly from these specimens. Among this material was *Coville & Funston 1355*, from which the illustration was made. Having the opportunity to see Dr. Greene's type while preparing the new revision for the North American Flora, I saw my mistake, and the plant described as *D. reflexa* in my monograph appears under the name *D. laxiflora* in the later work. In *D. laxiflora*, as well as in most species of the *D. Wrangelliana* group, the leaflets are rounded-obovate and the plant conspicuously viscid; while in Greene's specimens of *D. reflexa*

the leaflets, especially the terminal ones, are rhombic-obovate and the plant scarcely at all viscid. *D. laxiflora* is more closely related to *D. viscida* Parish, but differs in the broader ovate or oval bractlets, the more elongated and slender branches of the inflorescence, and the simple-toothed leaflets.

The following specimens belong to *Drymocallis reflexa:*

CALIFORNIA: Little Green Valley, San Bernardino Mountains, 1904, *R. Hall 7;* Nevada Falls, Yosemite Valley, 1902, *Hall & Babcock 3430.*

For several years there have been in the herbaria of the New York Botanical Garden, of Columbia University, and of the United States National Museum, several specimens resembling in many respects *Drymocallis Wrangelliana* and *D. oregana*, but with minute whitish petals. They could not be included in any of the previously described species. They resemble most closely *D. viscida* Parish, but the petals are white or whitish, not yellow, the plant is less viscid and the bractlets narrower. Besides, *D. viscida* was known only from southern California, and the specimens referred to come from Washington and British Columbia. In the North American Flora these specimens were described under the name *D. albida.* To it belongs the following material:

WASHINGTON: Damp or shady places at Bingen, 1893, *Suksdorf 2209;* Clallam County, June 1900, *Elmer 2526.*

OREGON: Forest Grove, June 3, 1893, *F. E. Lloyd.*

BRITISH COLUMBIA: Chilliwack Valley, July 10, 1901, *J. M. Macoun 34412* and *34441.* Skagit Valley, June 1905, *J. M. Macoun 69939;* Mt. Finlayson, Vancouver Island, June 3, 1887, *John Macoun.*

While collecting in Utah in 1905, the writer discovered another species closely related to the preceding, but differing in the orbicular instead of obovate petals and in the shorter and broader sepals. It was described in the North American Flora under the name *Drymocallis micropetala.* The following specimens belong to it:

UTAH: City Creek Cañon, June 9 and 12, 1905, *Rydberg 6153;* same locality June 9, 1883, *Leonard 105;* Red Rock Cañon, June 11, 1905, *Rydberg 6074.*

When preparing the manuscript for my monograph in 1896, I had not seen any specimens that agreed with Dr. Greene's description of *Potentilla lactea*. As most of the characterization of this species, according to Dr. Greene's own statements, were drawn from a "flower painting," the species was to my mind very doubtful. I have since seen several species from central and southern California which agree very well with Dr. Greene's description. These specimens resemble much in habit my own *Drymocallis gracilis*, but the petals are much smaller, scarcely exceeding the sepals, the plant is smaller and less viscid, and the stem leaves usually reduced. To *Drymocallis lactea* belong:

CALIFORNIA: Meadows above Bear Valley, July 23, 1906, *H. M. Hall 7562;* San Bernardino Mountains, Aug. 1, 1906, *Hall 7613;* vicinity of Hog Ranch, Yosemite National Park, July 1902, *Hall & Babcock 3391;* Griffins, July 1902, *Elmer 3978;* San Jacinto Mountains, July 1901, *Hall 2355;* Sawtooth Peak, 1904, *Hall & Babcock 5686.*

Dr. Wolf's treatment of the species belonging to this genus is altogether unsatisfactory. Of course he includes them in the genus *Potentilla*. *Drymocallis pseudorupestris* is made a variety of the European *Potentilla rupestris*, *D. convallaria* is made a variety of *P. arguta; D. lactea* is only mentioned under *Potentilla rupestris americana; D. rhomboidea* and *D. cuneifolia* are admitted as species; the rest are all bunched under *Potentilla glandulosa*. *D. incisa* and *D. Hanseni* are regarded as mere forms of *P. glandulosa genuina*. *D. fissa* appears under the name *P. glandulosa fissa* Th. Wolf, and *D. ashlandica* is made a mere form of the same. *D. valida* becomes *P. glandulosa glutinosa* and *D. glabrata* is regarded as a form thereof. *D. Wrangelliana* and *D. reflexa* are also regarded as varieties of *Potentilla glandulosa*. This treatment is at variance with the way the plants have been treated in this country, not only by Dr. Greene and myself, who have done the most work on the genera of Potentilleae, but by more conservative botanists. Professor Aven Nelson* regards *D. convallaria*, *D. pseudorupestris*, *D. fissa*, and *D. glutinosa* (= *D. valida*) as good species. These were the only Rocky Mountain species known

* New Manual of Botany of the Central Rocky Mountains.

besides *D. agrimonioides* (= *D. arguta*) and *D. glandulosa* until my revision in the North American Flora. Howell* admits *Potentilla glutinosa*, *P. ciliata* (= *D. ashlandica*), *P. fissa*, *P. glandulosa*, *P. Wrangelliana*, *P. reflexa*, and *P. rhomboidea*. Piper† admits *Drymocallis rhomboidea*, *D. pseudorupestris*, *D. convallaria*, *D. valida*, *D. glandulosa*, *D. glabrata*, and *D. Wrangelliana*. Blankinship‡, who belongs to the conservative school, admits *Potentilla fissa* and *P. rhomboidea* besides those found in my Flora of Montana, viz., *Drymocallis arguta*, *D. convallaria*, *D. pseudorupestris*, *D. glutinosa*, and *D. glandulosa*. Heller§ admits all the species included in my monograph of 1896. Hall ‖ admits *Potentilla lactea* and includes *Drymocallis viscida* Parish under the name *Potentilla glandulosa nevadensis*. Jepson,¶ who is very "conservative," on the contrary admits but one species, viz., *Potentilla glandulosa*. The plant described by him, however, is not *P. glandulosa* Lindley, but *P. Wrangelliana*.

CHAMAERHODOS

The American species of this genus has been regarded as identical with the Siberian *Chamaerhodos erecta* (L.) Bunge. Nuttall, one of America's most acute botanists, was the first to see the difference between the American and the Asiatic plant, and named the former *Chamaerhodos erecta parviflora*. Pickering regarded it as a distinct species, but his name *C. Nuttallii* was not properly published before the appearance of my revision in the North American Flora. In Torrey and Gray's Flora it appears as a synonym. The American plant has usually smaller flowers, the branches of the flat-topped inflorescence are strongly ascending, the pedicels erect or nearly so, and even in fruit scarcely exceeding the flower in length, while in *C. erecta* they are ascending and much longer.

NEW YORK BOTANICAL GARDEN.

* Flora of Northwest America.
† Flora of Washington.
‡ Montana Agricultural College Studies, 1, part 1.
‡ Catalogue of North American Plants, edition 2.
‖ Botanical Survey of San Jacinto Mountains.
¶ Flora of Western Middle California.

New species of Uredineae—VIII*

JOSEPH CHARLES ARTHUR

In continuing the monographic work on the rusts for the North American Flora it is found that apparently the following species have not been described. In order to place these species on record and to add such incidental information as may be at hand a brief account of the several forms is here presented.

Puccinia fidelis sp. nov.

O. Pycnia hypophyllous, grouped among the aecia, prominent, large, 112–144μ broad by 65μ high, with compact ostiolar filaments, reaching as much higher.

I. Aecia hypophyllous and caulicolous, scattered over the plant from a diffused mycelium, causing some hypertrophy and etiolation, chiefly on the woody tissues and hence often in rows along the veins, bullate, large, 0.8–1.3 mm. across, dehiscent by irregular slits, overarching epidermis reddish and prominent; peridium wanting; aeciospores globoid, usually 23–26μ; wall nearly or quite colorless, appearing thick, 2–3μ, coarsely verrucose.

II. Uredinia hypophyllous, scattered, round, small, dark cinnamon-brown; urediniospores globoid, usually 23–25μ in diameter; wall cinnamon-brown, rather thin, finely echinulate, pores usually inconspicuous, 2 near the hilum.

III. Telia hypophyllous, scattered, round, small, very pale brownish, cinereous by germination; teliospores oblanceolate or fusiform, 17–19 by 50–67μ, narrowed or obtuse at both ends, upper cell usually shorter and somewhat inverted topshaped; wall nearly or quite colorless, smooth, uniformly thin, 1μ; pedicel short, fragile.

On *Hyptis stellulata* Benth., hills near Guadalajara, Mexico, July 21, 1893, *C. G. Pringle*. The host of this rust was determined at the Gray Herbarium a short time ago. Through the kindness of Mr. A. B. Seymour the very ample original collection was placed at my disposal for study, and all stages of this charac-

* New species of Uredineae—I–VII. Bull. Torrey Club **28**: 661–666. 1901; **29**: 227–231. 1902; **31**: 1–8. 1904; **33**: 27–34. 1906; **33**: 513–522. 1906; **34**: 583–592. 1907; **37**: 569–580. 1910.

teristic species were easily worked out. All the shoots from the perennial roots of the host are invaded and altered by the gametophytic hyphae, showing that the mycelium probably hibernates in the crown of the plant. The sporophytic phase was not so well represented by the collection, and probably has a limited mycelium.

Puccinia exornata sp. nov.

O. Pycnia amphigenous, in small groups, large but sunken in the tissues and not especially conspicuous, 120–160μ in diameter, honey-yellow.

I. Aecia hypophyllous, in small groups surrounding the pycnia, on discolored and unthickened spots, roundish, 0.3–0.5 mm. in diameter, ruptured epidermis overarching, conspicuous; peridium wanting; aeciospores globoid, 24–27 by 26–32μ; wall colorless, 3–5μ thick, coarsely verrucose with closely set oval beads arranged in longitudinal or slightly spiral series.

II. Uredinia hypophyllous, scattered or somewhat grouped, round, 0.1–0.2 mm. across, soon naked, low, pulverulent, pale cinnamon-brown, ruptured epidermis inconspicuous; urediniospores globoid or obovate-ellipsoid, 20–24 by 24–30μ; wall thin, 1–1.5μ, very pale yellow, finely and sparsely echinulate, pores indistinct, apparently 3 and nearly equatorial.

III. Telia hypophyllous, similar to the uredinia but slightly larger and darker in color; teliospores oblong, 19–24 by 37–48μ, round at both ends, somewhat constricted at septum; wall golden yellow, smooth, 1μ thick, slightly thicker above, 2–4μ; pedicel colorless, slender, once to twice the length of spore.

On *Baccharis thesioides* H.B.K., Guatemala City, Dept. of Guatemala, Guatemala, alt. 1465 m., Feb. 2, 1905, *W. A. Kellerman 5368*. The uredinia and telia of this species are very similar to those of *Puccinia oaxacana* Diet. & Holw., but the aecia are wholly unlike, especially in the absence of a peridium and in the coarsely sculptured and thick-walled aeciospores. The host, *Kellerman 4375*, was determined by Mr. J. Donnell Smith.

Puccinia egregia sp. nov.

O. Pycnia hypophyllous, numerous, especially along the veins, preceding the aecia, inconspicuous.

I. Aecia hypophyllous and caulicolous, abundant, scattered over the whole plant from a diffused mycelium, causing etiolation, at first more numerous along the stems and veins, mostly oval,

large, 0.5–1 mm. across, the prominent peridium soon bursting through the swollen reddish base; peridium cylindrical, or flattened laterally, large, 0.3–0.5 mm. in diameter by 0.5–0.8 mm. high, fragile and somewhat evanescent; aeciospores broadly ellipsoid or globoid, 16–21 by 19–26μ; wall colorless, thin, 1.5μ, strongly verrucose with closely set beads.

II. Uredinia not seen; urediniospores mixed with the teliospores, globoid, about 23–27μ in diameter; wall cinnamon-brown, rather thin, 1.5μ, finely echinulate, pores indistinct, apparently 2 and equatorial.

III. Telia hypophyllous, scattered, round, usually small, 0.1–0.2 mm. across, early naked, loosely pulvinate, becoming pulverulent, chestnut-brown; teliospores ellipsoid or obovate-ellipsoid, 21–27 by 35–45μ, rounded or somewhat narrowed at base, obtuse or rounded at apex; wall cinnamon-brown, minutely granular, 1.5μ thick, much thicker at apex by a broad pale umbo, 6–10μ, often appearing vertically striate; pedicel colorless, delicate, short.

On *Baccharis oaxacana* Greenm., Mt. Oaxaca, Mexico, alt. 2850 m., June 23, 1894, *C. G. Pringle*. Through the kindness of Mr. A. B. Seymour, I was enabled to examine the large original collection of this species. The host was determined at the Gray Herbarium in February 1911. The aecial mycelium causes a marked change in the host, turning it pale and giving a drawn appearance. The sporophytic stages appear sparingly on the least changed leaves.

Puccinia sphenica sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia chiefly hypophyllous, scattered, round, very small, light cinnamon-brown, pulverulent, ruptured epidermis noticeable; urediniospores broadly obovoid, 19–23 by 24–30μ; wall tawny or nearly colorless, 1.5μ thick, minutely and rather closely echinulate, pores indistinct, 3 or 4, equatorial.

III. Telia hypophyllous, scattered, small, pulvinate, chestnut-brown, ruptured epidermis inconspicuous; teliospores ellipsoid, 27–32 by 35–45μ, rounded at both ends; wall smooth, chestnut-brown, concolorous, 2.5–4μ thick, thicker above, 4–9μ; pedicel often inserted obliquely, nearly or quite colorless, terete, fragile, about once length of spore.

On *Baccharis sordescens* DC., Cuernavaca, State of Morelos, Mexico, Oct. 29, 1903, *E. W. D. Holway* 5266. From other North

American species of *Puccinia* on *Baccharis* having teliospores smooth, this species is readily separated by the unusually thick walls of the teliospores.

Puccinia pistorica sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia hypophyllous, abundant, scattered, roundish, large, for some time partially covered by the overarching epidermis, light cinnamon-brown; urediniospores globoid or obovate-globoid, 24–32 by 30–39μ; wall pale yellowish, about 2μ thick, sparsely and strongly echinulate, pores very indistinct, probably few and scattered.

III. Telia amphigenous, in compact irregular groups, of varying size from 0.1 to 1 mm. across, chocolate-brown or blackish, usually shining; teliospores linear-oblong or oblong-lanceolate, small, 12–16 by 39–50μ, obtuse or rounded above, narrowed below; wall smooth, chestnut-brown above, much lighter toward the base, 1–1.5μ thick at sides, 6–12μ thick above; pedicel tinted, slender, one-half length of spore or less.

On *Baccharis glomeruliflora* Pers., Mt. Dora, Florida, March 25, 1891, *L. M. Underwood*. This species is distinct from all other species of *Puccinia* on *Baccharis* that the writer has examined, in the compact and glossy teliosori. The spores show no evidence of germination in the specimen examined. The material in hand, for which I am indebted to Prof. E. W. D. Holway, is scanty, however, and a more extended account must await the collection of better material, which should also supply the pycnial and aecial characters. The locality where the collection was made, as I learn from Mr. P. L. Ricker, is near Lake Dora, on the Tampico and Key West railway, and about halfway between the stations of Tavares and Sorrento. The fungus is not inconspicuous, and is likely to be found throughout southern Florida when searched for.

Puccinia pagana sp. nov.

III. Telia amphigenous, scattered, oval, 0.1–0.4 mm. broad by 0.2–0.7 mm. long, tardily naked, cinnamon-brown, somewhat pulverulent, ruptured epidermis falling away from above the sorus; teliospores oval or oblong, 18–23 by 27–35μ, rounded or obtuse both above and below, not constricted at septum; wall cinnamon-brown, 1.5–2μ thick, often slightly thickened above, 3–4μ, sometimes simulating a pale papilla, finely and inconspicuously verru-

cose, more evidently so above; pedicel colorless, slender, fragile, half length of spore or less.

On *Allium reticulatum* Don, Dead Lake, Pikes Peak, Colo., 3500 meters alt., August 20, 1904, *F. E. & E. S. Clements* (Clements, Crypt. Format. Color. *141*). The collection was issued under the name *P. mutabilis*, but differs from that species in the more oval teliospores without constriction, and with distinctly verrucose surface. No urediniospores are present, not even in the teliosori. Whether urediniospores and aeciospores occur in the life cycle, or not, can not be told or even inferred from the material in hand. Even the material of the host is scanty, showing neither flowers nor bulbs, and some doubt must attach to its correct determination. As it has been impossible to match this material with any other known rust, it is recorded here to attract the attention of collectors.

Uromyces aemulus sp. nov.

O. Pycnia very few, punctiform.

I. Aecia amphigenous, rather closely but irregularly arranged in oval groups 0.5–1 mm. long, on pale unthickened spots, cylindrical, margin erose or somewhat lacerate; aeciospores globoid or irregularly ellipsoid, 20–24 by 23–26μ, often angular; wall pale yellow, 1.5–2μ thick, finely verrucose.

II. Uredinia amphigenous, widely scattered, oblong or oval, 0.5–2 mm. long, dehiscent by longitudinal slits, yellow or light cinnamon-brown; urediniospores globoid or broadly ellipsoid, 22–29 by 25–33μ; wall golden yellow, 1.5–2μ thick, inconspicuosly echinulate, pores indistinct, 5–8, scattered.

III. Telia amphigenous, scattered, prominent, usually oblong, 0.8–3 mm. long, at first covered by the gray epidermis, eventually naked, somewhat pulverulent, dark chocolate-brown or blackish; stroma absent; teliospores globoid or obovate-globoid, 18–24 by 24–30μ; wall chestnut-brown, concolorous, 2–2.5μ thick, slightly or not thickened above, 2.5–4μ, smooth; pedicel slender, about once length of spore.

On *Allium brevistylum* S. Wats., Yanceys, Yellowstone National Park, Wyoming, July 17, 1899, *A. & E. Nelson 5920* (type). The host was determined by Dr. P. A. Rydberg, January 1907, from the specimen in the cryptogamic herbarium of the New York Botanical Garden. Sori of all spore forms are fairly well represented in this collection. They bear the customary relation

to one another on the leaves of the host that is usual in autoecious species. The following specimens also belong here: on *A. brevistylum* S. Wats., Big Horn Mts., Wyo., August 1898, *T. A. Williams & D. Griffiths*, III; Ten Sleep Lakes, Big Horn Co., Wyo., July 30, 1901, *Leslie N. Goodding 422*, II & III; Hot Sulphur Springs, Colo., 2340 m. alt., July 24, 1907, *E. Bethel*, II & III; on *A. validum* S. Wats., Pine Forest Mts., Nev., July 1901, *Griffiths & Morris*, II & III (Griff., West Am. Fungi *391*); and intermixed with *Puccinia Blasdalei* D. &. H. on *A. acuminatum* Hook., Farmington Canyon, Davis Co., Utah, June 3, 1904, 1700 m. alt., *A. O. Garrett*, III (Garrett, Fungi Utahenses *83*).

This species is most easily confused with *Uromyces aureus* D. & H., but that species, which is known only from a single collection made in California on *Allium validum* in 1892, has larger spores, entire absence of urediniospores, and a different disposition of aecia and telia on the leaf, the aecia closely surrounding the groups of telia, and both seemingly arising from the same mycelium.

The type collection was first distributed under the name *Uromyces bicolor* E. & E., and other Wyoming specimens under the name *U. aterrimus* D. & H., which is a synonym of the preceding, but that species, generally at lower levels, has strictly subepidermal telia with well developed stromata, and urediniospores with a larger number of especially distinct pores. In its urediniospore it is similar to the European *U. ambiguus* (DC.) Fckl., but that species has permanently covered telia, and obovate teliospores.

The *Allium* species of *Puccinia* are much given to the production of mesospores, in some sori even to the exclusion of the two-celled spores, but these can be distinguished from the present species by morphological characters. The collection distributed in Garett's Fungi Utahenses, *83*, consists of a mixture of *U. aemulus* and *P. Blasdalei* D. & H. The telia are quite readily separated under a hand lens. Those of the *Uromyces* are grayish and inclined to be naked, while those of the *Puccinia* are quite black and closely covered. The mesospores of the latter have a semihyaline, thickened apex and are not globose.

There has been much confusion in determining the American *Allium* rusts. Most collections are not provided with either flowers or bulbs, which are usually needed to name the hosts, but

fortunately the morphological characters derived from the spores, and the geographical range, afford better diagnostic data than the host species. On the plains between the Mississippi River and the foothills of the Rocky Mountains a number of collections of aecia on *Allium* have been made, which may be placed under the name *Aecidium alliicola* Wint., that may or may not belong to *Puccinia Winteriana* Magn., having uredinia and telia on the grass *Phalaris*. From all that is known of their occurrence and structure, the connection seems probable, the *Allium* and *Phalaris* stages having been collected near each other, although no cultures have been made. Considerable study has recently been given to this group of rusts, and as a result the following key is introduced here to assist collectors.

Key to American and European Allium rusts

- Teliospores smooth.
  - Teliospores two-celled (*Puccinia*), often with mesospores.
    - Teliospores strongly thickened above, 7–10μ.
      - Aecia absent.
        - Urediniospores with 6–8 scattered pores (not in America). *P. Allii.*
      - Aecia present.
        - Urediniospores with 6–8 scattered pores. *P. Blasdalei.*
        - Urediniospores with 3 or 4 equatorial pores (rarely on *Allium*). *P. Asparagi.*
    - Teliospores not or slightly thickened above, 3–5μ.
      - Autoecious, aecia amphigenous.
        - Telial stromata present, sometimes strongly developed.
          - Urediniospores with 8–12 scattered distinct pores. *P. granulispora.*
          - Urediniospores with 7–9 scattered indistinct pores (rare in America). *P. Porri.*
        - Telial stromata absent.
          - Urediniospores with 6–8 scattered distinct pores. *P. mutabilis.*
      - Heteroecious, aecia (on *Allium*) chiefly hypophyllous.
        - Urediniospores (on *Phalaris*) with 4–6 scattered indistinct pores. *P. Winteriana.*
  - Teliospores one-celled (*Uromyces*).
    - Telia tardily naked.
      - Urediniospores with 6–8 scattered indistinct pores. *U. aemulus.*
    - Telia permanently covered.
      - Teliospores not thickened above. *U. aureus.*
        - Teliospores somewhat thickened above.

Urediniospores with 7–12 scattered distinct pores.	*U. bicolor.*
Urediniospores with 5–7 scattered indistinct pores (not in America).	*U. ambiguus.*
Teliospores rough.	
Teliospores two-celled (*Puccinia*).	
Teliospores coarsely verrucose (rarely on *Allium*)	*P. Calochorti.*
Teliospores inconspicuously verrucose.	*P. pagana.*
Teliospores one-celled (*Uromyces*).	
Teliospores finely striate (rarely on *Allium*).	*U. primaverilis.*
Teliospores coarsely striate (not in America).	*U. reticulatus.*

Uromyces probus sp. nov.

O. Pycnia not seen.

I. Aecia amphigenous, on the veins in series 1–3 mm. long, short, cupulate, 0.3–0.4 mm. in diameter; peridium erect or spreading, margin erose; aeciospores broadly ellipsoid, 18–21 by 23–26μ; wall colorless, about 1.5μ thick, finely verrucose.

II. Uredinia amphigenous, solitary or in crowded groups 2–8 mm. across, oblong or linear, 0.5–5 mm. long, rather soon naked, light cinnamon-brown; urediniospores broadly ellipsoid, 19–23 by 26–31μ; wall golden yellow, 2–3μ thick, sparsely echinulate with fine short points, pores 5 or 6, scattered.

III. Telia amphigenous, scattered, numerous, oblong or linear, 0.5–4 mm. long, rather tardily naked, chocolate-brown, ruptured epidermis conspicuous; teliospores broadly ellipsoid or obovate-ellipsoid, 16–21 by 23–29μ; wall dark cinnamon-brown, about 1.5μ thick, slightly thicker above, 2–3μ, smooth; pedicel slightly tinted, usually shorter than spore.

On *Olsynium grandiflorum* (Dougl.) Raf. (*Sisyrinchium grandiflorum* Dougl.), Columbia River, Wash., July 1893, *W. N. Suksdorf* (Ellis & Ev. N. Amer. Fungi *3137*). The type collection was distributed under the name *Uromyces Sisyrinchii* Mont., a name established upon the uredinia of *Puccinia Sisyrinchii* Mont., according to Messrs. Hariot and Sydow (cf. Sydow, Monog. Ured. 1: 601). The only other species of *Uromyces* on *Sisyrinchium* known in either North or South America is the heteroecious species occurring in the eastern United States, *U. Houstoniatus*, which differs conspicuously from the western form not only in having its aecia on an unrelated host, but in the characters of the sori and of the urediniospores and teliospores. Beside the type collection another was made by Mr. Suksdorf on May 24, 1894, but otherwise with same data. A specimen of the same rust was collected on

Sisyrinchium sp., Lake Waha, Nez Perces Co., Idaho, June 27, 1896, *A. A. Heller 3331*.

Uromyces major sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia amphigenous, scattered, oval or oblong, 0.3–1 mm. long, cinnamon-brown; urediniospores broadly ellipsoid, 19–23 by 21–26μ; wall light golden yellow, 2–2.5μ thick, strongly and evenly echinulate, pores 4, equatorial.

III. Telia amphigenous, similar to uredinia, blackish brown; teliospores broadly ellipsoid, 19–23 by 23–27μ, usually rounded at both ends; wall chestnut-brown, not concolorous, 2–2.5μ thick, thicker above, 5–9μ; pedicel slightly tinted, 5–7μ in diameter, once to twice length of spore.

On *Muhlenbergia* sp., near City of Mexico, Mex., Oct. 2, 1896, *E. W. D. Holway*. The collection on which this species is founded is meager and the host is not fully determined, but the rust seems so distinct from any other species of *Uromyces* on grasses, that I venture to record it as a form hitherto undescribed. It differs from the only other North American species of *Uromyces* on *Muhlenbergia, U. minimus* Davis, in the much larger spores, in the not concolorous and thicker-walled teliospores, and in the very different range.

Uromyces mysticus sp. nov.

O and I. Pycnia and aecia unknown.

II. Uredinia chiefly epiphyllous, scattered, oblong or linear, 0.5–1.2 mm. long, rather early naked, golden brown, ruptured epidermis conspicuous; urediniospores broadly ellipsoid, 24–28 by 27–32μ; wall golden yellow, 2–2.5μ thick, finely and inconspicuously echinulate, pores 8–12, scattered.

III. Telia chiefly hypophyllous, similar to the uredinia, but remaining covered by the epidermis; teliospores angularly obovate, 18–26 by 26–33μ, rounded or angular above, usually somewhat narrowed below; wall chestnut-brown, moderately and uniformly thick, 2–2.5μ, finely and inconspicuously verrucose; pedicel light yellow, one-half to once length of spore.

On *Hordeum jubatum* L., Denver, Colo., Oct. 29, 1910, *E. Bethel* (Barth., N. Amer. Ured. *91*). This species is readily distinguished from *Uromyces Hordei* Tracy, a somewhat common and more widely distributed form, by the finely verrucose teliospores, which are not thickened at the apex, and by other less

pronounced differences. A collection on *H. jubatum* made at Provo, Utah, without date, *S. M. Tracy 712*, is the only other material belonging to this species that I have seen. Although the rust is on a very common and widely distributed host, it seems to be rare or restricted in its distribution. Possibly it has been overlooked by collectors, owing to its being rather inconspicuous. Without examination under the microscope it might readily be mistaken for the common subepidermal *Puccinia* on the same host, which goes under the name *P. rubigo-vera*.

Uromyces agnatus sp. nov.

II. Uredinia chiefly hypophyllous, scattered, often confluent, irregularly roundish, 0.2–0.5 mm. across, early naked, soon aplanate, somewhat waxy, light cinnamon-brown, ruptured epidermis conspicuous; urediniospores broadly ellipsoid, 18–23 by 21–29μ; wall light golden brown, rather thick, 2–2.5μ, sparsely and inconspicuously echinulate, pores usually distinct, 2, opposite and equatorial.

III. Telia chiefly hypophyllous, scattered, roundish, 0.1–0.4 mm. across, at first bullate, soon naked, pulverulent, dark chocolate-brown; teliospores oval, somewhat narrowed above and below, 23–29 by 29–35μ; wall chestnut-brown, 3–4μ, slightly thicker above, 5–7μ, coarsely and inconspicuously verrucose; pedicel colorless, slender, fragile, about length of spore.

On *Jatropha stimulosa* Michx., Dunedin, Fla., Nov. 26, 1901, *S. M. Tracy 7278* (type); Sanibel Island, Fla., May 17, 1901, *S. M. Tracy 7234;* Summerville, S. C., Aug. 13, 1902, *C. L. Shear 1553;* Lake Worth, Fla., July, 1894, *P. H. Rolfs 17;* Jensen, Fla., no date, *P. H. Rolfs 55*. This species has been confused with the wholly distinct Mexican species on *Jatropha*, *Uromyces oaxacanus* D. & H. In Sydow's Monog. Ured. 2: 183, the description under *U. oaxacanus* is chiefly that of the northern species. In Mexico there is still a second distinct species on *Jatropha*, *U. Jatrophae* D. & H.

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Development of the embryo sac and endosperm in some seedless persimmons

William L. Woodburn

(with plate 16)

Some time ago observations were made on the development of seedless persimmons (*Diospyros virginiana* L.) in the neighborhood of Indiana University. Two or three questions then suggested have been at least partly answered as the result of further investigation. In addition certain facts have been obtained in regard to the development of the embryo sac and endosperm, which may be of sufficient interest to merit publication. After a brief report on the subject in the Proceedings of the Indiana Academy of Science, 1908, other work prevented further studies along that line until this winter.

All the persimmon trees found in the vicinity of Indiana University are strictly dioecious. The pistillate flowers have aborted stamens and the staminate flowers have rudimentary carpels. In none of the former is there a suggestion of the development of pollen. Pollination must then be effected through the agency of insects, particularly bees, which frequent the blossoms in great numbers. Some pistillate trees are as far as three or four miles from any known staminate ones, consequently as large a number as 70 per cent or 80 per cent of the flowers frequently fail to be pollinated. These develop fruits usually of a smaller size but otherwise not of inferior quality. The relative number of seedless berries on an individual tree varies from year to year. Neither is there any special localization of the two kinds except that fewer seeds are found on the lower branches. The fruits developed in the near vicinity of staminate trees are usually quite full of seeds, seldom any being entirely without.

As suggested above, a larger fruit is usually developed from those flowers in which pollination has occurred, but there are many trees on which a large per cent habitually fail to be polli-

nated. The fruits of the latter, however, continue to develop and the integuments of the ovule often enlarge considerably into flat thin seedlike bodies. The structures in the ovules are very hard to procure in proper sections for staining, due to the very hard nature of the integuments. Therefore great care was exercised in arriving at conclusions in regard to the presence or absence and the nature of certain structures in the embryo sac.

The sections for microscopical studies were all made from ovaries that would evidently have formed seedless fruits, as no indications of pollen tubes were evident, and preparations were examined which included the earlier stages in the development of the embryo sac as well as later ones showing the parts nearly or quite degenerate. The considerations then in the following paper must be taken to refer to "seedless persimmons," as none of the material on hand contained evidence of embryonal development, and later observations showed that the trees from which the material was taken bore a very high percentage of seedless fruits.

THE DEVELOPMENT OF THE EMBRYO SAC

Only a small nucellus is formed, PLATE 16, FIG. 13 representing its greatest development but showing no indications of a spore mother-cell or spores. The earliest stage observed in the development of the embryo sac is shown in FIG. 1. Only two nuclei are present and these are near the chalazal end. Whether this condition represents a normal stage or an incomplete development I am unable to say, for many preparations of incompletely developed embryo sacs were found. The growth of the embryo sac takes place well toward the micropylar end of the nucellus, all of this portion eventually breaking down, leaving a small but quite persistent remnant at the opposite extremity. FIG. 2 shows a condition frequently met with. The egg apparatus seems quite normally developed and the polar nuclei are closely associated. The two latter have not been observed in an actual state of fusion although some preparations show the contiguous sides to be somewhat flattened (FIG. 4). Other sections of the same ovule (FIG. 2) show one or two antipodal cells, but frequently these are not of definite form or constant in number. FIG. 3 shows three antipodal cells all present in the same section. Only two cells

of the egg apparatus are shown but the third cell is present in the succeeding section of the series. Traces of the polar nuclei are present, one of which lies in the neighboring section but the other one is apparently disorganizing. No later stage in the fusion of the polar nuclei was observed than that shown in FIG. 4, where they are merely very closely associated. FIG. 5, 6, and 7 represent a condition which seems difficult of explanation and yet is consistent with facts brought out in FIG. 8–11. By following through the successive sections of this ovule (FIG. 5–7) three nuclei were found in the region usually occupied by the egg apparatus. FIG. 5 shows one nucleus lying in a large cell not unlike an egg cell. FIG. 6, which is the succeeding section, contains a nucleus in a denser cytoplasmic mass nearer the periphery of the embryo sac, and the next section shows the third nucleus in a still denser mass at nearly the opposite side of the sac. This latter mass appears to be of a mucilaginous nature, only a portion of it differentiating like the ordinary cytoplasm of the egg apparatus. FIG. 6 and 7 do not appear to represent either egg cell or synergids but resemble more nearly disorganizing nucellar tissue. (Compare FIG. 1 and 4.) However, FIG. 5–7 may merely represent a breaking down egg apparatus consequent to the failure of fertilization. Disorganizing nuclei of the nucellar tissue lie in the peripheral cytoplasm of the embryo sac.

I am convinced that a complete embryo sac is not always organized, and that even in the absence of fertilization, whether completely organized or not, development in the sac does not always cease at this point. FIG. 8 and 9, drawn from the micropylar end of the embryo sac, seem to be a slightly more advanced stage. They represent neighboring sections of the same ovule but two distinct groups of cells. The cells of FIG. 8 more nearly resemble those of the egg apparatus than do those of FIG. 9. A similar condition is shown in another ovule (FIG. 10). Neither evidence of fertilization nor development of the egg were discovered at this or later stages, but nuclei appear around the periphery and somewhat more numerous in the micropylar region of the embryo sac. The entire history of these nuclei has not been traced but their appearance would suggest that they may have originated from the polar nuclei. That they represent an early stage of

endosperm formation is quite clear. (Compare FIG. 10, 11, and 12.) Development proceeds more rapidly in the micropylar portion, which may be for a time separated from the opposite or chalazal region (FIG. 11). The cellular endosperm continues its inward development until the entire cavity is filled. In the region formerly occupied by the egg there are usually remnants of broken down tissue (FIG. 12). Although the sections were all examined carefully, there were no indications of a pollen tube having penetrated, nor of an embryo at least as far as the ovule.

The development of the endosperm in the seedless persimmon agrees with that noted within recent years for a few other plants but not conforming to the generally accepted theory of endosperm development in angiosperms.

Juel ('98) found that the polar nuclei in *Antennaria* come close together but do not fuse. On the contrary they separate and form endosperm at the same time that the egg parthenogenetically develops an embryo.

Coulter ('98), in *Ranunculus multifidus*, found free nuclear formation of endosperm before fertilization. He suggests that the presence of the pollen tube in the pistil may cause this premature formation. Practically the same conditions with no evidence of fertilization were observed by Smith ('98) in *Eichhornia crassipes*.

Overton ('02) discovered along with parthenogenesis in *Thalictrum purpurascens* the endosperm nucleus always dividing before the egg. Johnson ('02) found similar conditions in *Piper medium* and *Heckeria umbellata*.

Coker ('07) observed endosperm development in *Pontederia cordata* and *Heteranthera limosa* taking place in two distinct regions, a smaller antipodal and a larger micropylar. I find that somewhat the same condition may obtain in the seedless persimmon, except that the chalazal portion in the latter is relatively much larger than those figured by Coker for *Pontederia* and *Heteranthera*. The figures of Smith ('08) show a striking similarity to my FIG. 10 and 11.

CONCLUSIONS

That any of these features are constant for the seedless persimmon is not at all certain, on the contrary there seems to be

a great variation. A fully developed embryo sac is not always formed before the parts begin to disorganize. There is a tendency toward incomplete organization especially of the antipodal cells. The egg apparatus is, of all the parts observed, most frequently in a state of complete organization but it too may break up prematurely. The polar nuclei are often observed in close contact but never in a state of fusion. The integuments frequently push in at this stage and obliterate the cavity of the embryo sac without further development of the latter. However, considerable endosperm tissue may be produced while at the same time the cells of the egg apparatus disorganize. This development of endosperm is more rapid in the region of the micropyle and may be separated at first from the tissue in the opposite portion. At first free nuclei are observed scattered in the peripheral layer of cytoplasm, then cell formation begins and gradually extends toward the center until the cavity of the embryo sac is completely filled with a cellular endosperm tissue.

It may be of interest also to note that a very defini e nutritive jacket layer of cells is organized from the inner integument (FIG. 3 and 11), and that, although only a small nucellus is formed (FIG. 13), a relatively large portion of it is quite persistent.

It remains an open question as to the stimulus causing the occasional development of endosperm without fertilization. There is the possibility of the presence of pollen tubes in the upper part of the pistil, or at least outside of the ovule, but developing too late to effect fertilization. Whatever may be the stimulus, a well organized endosperm may develop without the initiation of an embryo.

I hope to procure material this summer from trees developing fertile seeds in order to trace the embryology. Experimental plantings show that a large per cent of the well developed seeds germinate readily.

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Explanation of plate 16

FIG. 1. A two-nucleated embryo sac, upper part of nucellus disorganizing. × 450.

FIG. 2. Egg apparatus and polar nuclei. One or two antipodal cells were present in the next section. × 450.

FIG. 3. Embryo sac showing antipodals. Upper part of nucellus has disappeared. × 450.

FIG. 4. Egg apparatus. Polar nuclei flattened on contiguous sides. × 525.

FIG. 5, 6, and 7 are successive sections of the same ovule. × 150.

FIG. 6 and 7 represent only the micropylar region.

FIGS. 8 and 9 are successive sections through corresponding regions of an older embryo sac, showing two distinct groups of cells. × 150.

FIG. 10. Section of embryo sac showing peripheral endosperm nuclei and a group of disorganizing cells, evidently the egg apparatus. × 55.

FIG. 11. Showing the development of the endosperm in two regions. × 55.

FIG. 12. Endosperm completely filling the embryo sac. × 55.

FIG. 13. Outline sketch showing extent of nucellus surrounded by inner integument, before formation of megaspore.

Teratological fruits of Ptelea

J. Arthur Harris

(WITH PLATE 17)

For the most part the literature of plant teratology is composed of purely casual observations, chiefly records of bizarre structures which have caught the attention of the observer who contented himself with describing and theorizing. But the work of Magnus, Masters, Penzig, de Vries, Vöchting, and some others has shown that teratology can be taken up as a problem for serious and continued work, and with profitable results.

Some years ago I became much interested in certain problems involving the frequency and degree of development of plant anomalies commonly classed as teratological. Among the things it is desirable to determine concerning teratological structures through the examination of large series of material are:

Frequency of occurrence.

Range of variability in development.

Continuity or discontinuity in development.

One of the series of material upon which observations were begun in the winter of 1907 I have not found time nor opportunity to continue and the data are put on record here for the benefit of anyone occupied with problems of this kind.

Several observers have described trimerous fruits in *Ptelea trifoliata*, as Roeper,* Schimper,† and Masters.‡ As material for further work I used the numerous fruits of eleven shrubs growing in the North American Tract of the Missouri Botanical Garden. Two objects were in view. First, to gain some rough approximation to the frequency with which anomalous fruits occur. Second, to ascertain whether the limit of variability of the fruit is reached with the typical two-winged and three-winged forms, and especially to find by extensive series of countings whether there is perfect

* Roeper, J. Linnaea 2: 85. 1827.

† Schimper, C. Flora 12: 433. 1829.

‡ Masters, M. T. Vegetable Teratology 364. 1869.

discontinuity between di- and trimerous fruits, or whether these two types are connected by transition stages. If transitional conditions are found their rélative frequency of occurrence was to be gotten.

Nine classes of fruits were recognized among twenty-nine thousand examined. The distribution of the fruits among these classes is shown in the table.

TABLE OF FREQUENCY

CLASS OF FRUIT	Number of Shrub											Totals
	A	B	C	D	E	F	G	H	I	J	K	
1. One wing only developed .	—	—	—	—	—	1	1	—	—	—	1	3
2. Normal 2-winged condition	4,400	1,077	1,797	4,080	2,238	923	3,969	772	3,257	3,865	2,323	28,701
3. Third wing present but less than half developed .	4	10	—	4	3	—	4	1	—	10	—	36
4. Third wing incomplete but over half developed	—	—	1	3	—	—	1	1	—	2	—	8
5. Typical 3-winged condition	17	22	2	40	11	—	14	3	15	69	4	197
6. Four wings, but 2 imperfectly developed	—	1	—	—	—	—	—	—	—	—	—	1
7. Four wings, but 1 imperfectly developed	—	—	—	—	—	—	—	—	—	—	—	—
8. Typical 4-winged condition	—	2	—	—	1	—	—	—	—	1	—	4
9. Paired fruits on the same pedicel	—	(1)*	—	—	(1)	—	—	—	—	(1)	—	(3)

* This pair belonged to class 3 and is counted in with the 10 there.

It appears that in the individuals examined the anomalous fruits were rare; those with but a single wing occurred in only one one-hundredth of one per cent of the cases examined; the typical three-winged fruits formed far less than one per cent of the series. No stress is to be laid on these figures, for the percentage of anomalous organs may vary greatly from shrub to shrub; the relative proportion of the different grades of anomaly is of greater interest.

It is quite clear that conditions 3 and 4 are much more rare than either 2 or 5, but even with nearly 29,000 observations the numbers are too small to determine whether transitional stages between trimerous and tetramerous fruits are rare as compared with the perfectly developed condition.

Generally two-winged fruits have two cells while three-winged fruits have three cells. A considerable series of fruits, many of them not included in the table, were sectioned to verify this point. Incidentally the number of seeds developing was noted.

Fruits with two wings and two locules may have 0, 1, or 2 seeds. For frequencies I found:

Seeds	0	1	2	Total
Frequencies	47	412	77	536

Likewise for the three-winged fruits:

Seeds	0	1	2	3	Total
Frequencies	33	159	80	15	287

Of the 287 three-winged fruits, thirteen were possibly bilocular; the remainder were clearly trilocular. Perhaps in these apparently bilocular fruits the partition wall had simply broken down, but two wings may have developed on the backs of some of the carpels.

For the mean number of seeds per locule we have:

Two-winged, $A = 1.056$.
Three-winged, $A = 1.268$.

But I lay no stress on the comparison, both because of the smallness of the number of pods dealt with, and because the two-winged fruits sectioned were not gathered in proportion to the three-winged fruits from each individual tree, but were merely a random sample saved for another purpose. A detailed study of material so collected that the possibility of difference in fecundity of individual trees could not cast doubt on the results, might be profitable.

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Explanation of plate 17

Diagrams of normal and abnormal fruits of *Ptelea*. FIG. 1; class 1. FIG. 2, 3; class 2, *in toto* and in cross section. FIG. 4; class 4. FIG. 5–7; class 5, *in toto* and in cross section. FIG. 8, 10; class 8. FIG. 9, 11; class 9.

Description of two new fossil figs from Wyoming and Montana *

F. H. KNOWLTON

The fossil fruits herein described have been in hand for many years awaiting the completion of a large general work that should deal fully with the floras of certain of the Upper Cretaceous and Lower Tertiary formations of the Rocky Mountain region. As a wealth of new material has yearly continued to pour in from these horizons, the completion of the work has been of necessity delayed, and it may still be some time before it can be finished. In the meantime it seems desirable that some of the more striking or interesting of the new forms should be published in order that they may be made available for the use of other workers in the field. The present paper, which will be followed by others, deals with two remarkable fruits of *Ficus* from Wyoming and Montana.

Ficus Ceratops sp. nov.

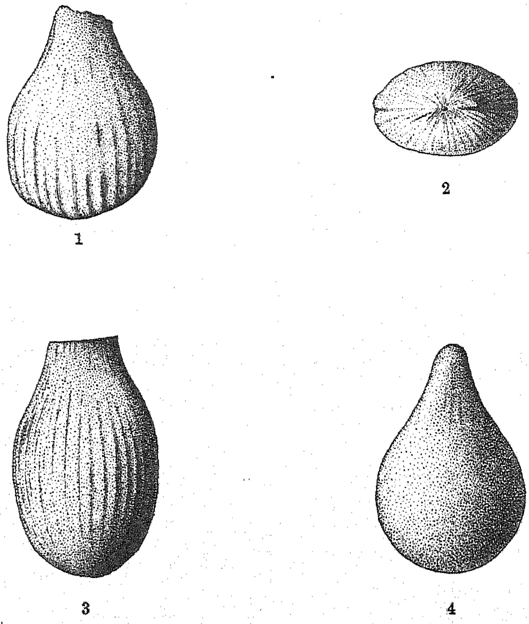
Palmocarpon n. sp. Knowlton, in Stanton and Knowlton, Bull. Geol. Soc. Am. **8**: 136. 1897.

Fruits pearshaped or obovoid in shape, narrowed proximately into a thick neck (usually broken), and globosely expanded distally; walls thick and apparently woody in texture, usually provided with numerous, more or less prominent ribs which converge in the narrowed neck; apex rounded and obtuse or slightly depressed to a small pit or apparent opening into the interior; seeds absent, the interior being filled with coarse sandstone of the matrix. [See FIGURE.]

These remarkable and admirably preserved specimens, of which there are nearly one hundred before me, were collected by the late J. B. Hatcher on June 24, 1881, in Converse County, Wyoming, in beds of the Lance formation, which contained abundant remains of the now well known horned dinosaurs. They were thought by the collector to be the bulbs of some monocotyledonous plant, and this supposed resemblance is by no means far fetched. They were all found within a very small area, and, according to Mr. Hatcher, each one when discovered was resting with the large globular

* Published with the permission of the Director of the U. S. Geological Survey.

end downward, a position that heightened their resemblance to small bulbs, at least to the casual observer. Without careful study they were supposed to be palm fruits, and in the paper above mentioned they are recorded as a new species of *Palmocarpon*. But on careful study it appeared that they failed to meet the requirements for a reference to the palms, and in casting about for possible relationship it was suggested to me by Mr. F. V. Coville,



Ficus Ceratops sp. nov. 1, 3, and 4, side views of fruits; 2, end view of 1.

botanist of the United States Department of Agriculture, that they were probably fruits of a species of *Ficus*, and such they undoubtedly are. In the seed collection of the United States National Herbarium I find (*no. 11,713*) a single woody fruit of a *Ficus*—unfortunately without specific name—from Egypt that is hardly to be distinguished from them. This is of approximately the same size and is of precisely the same shape and appearance as the fossils, having a thick woody "shell" provided with numerous somewhat finer ribs or striae, the main point of difference being in the apex, where the entrance to the interior cavity is much larger and practically closed by a woody diaphragm or protuber-

ance from the interior. In the fossils the presence of this pore is demonstrable, but it must have been much smaller and not provided with anything like a diagram. Curiously enough the fossils show little if any evidence of pressure or distortion, which is probably to be accounted for by the fact that the beds in which they occur are nearly horizontal and exhibit no evidence of having been much disturbed since their deposition. They have what was probably a thick, woody "shell," which in all cases appears to have been broken across the neck or basal portion just above the point of attachment, thus permitting access to the interior cavity. This cavity is now filled with the coarse sandstone of the general matrix, mixed with certain extraneous matter, as bits of vegetation, fragments of shells, etc. In no case was the cavity found to contain seeds, which seems rather remarkable considering the fine state of preservation of the fruit as a whole. It seems probable that when the neck was broken the larger, globose end, being heavier, floated downward and the fruits were filled and covered up in this upright position in which they are found.

It should be mentioned that the approximate size of these fruits is as follows: length 2 to 3.5 cm., diameter of neck usually a little less than 1 cm., and the diameter of the globular portion about 2 cm. While these sizes are much larger than the average living *Ficus* fruit there are a number of well-known species having them even larger, such, for instance, as the Indian *F. punctata* Thunb., *F. callicarpa* Miq., and others.

Fruits of *Ficus* in a fossil state are of unusual occurrence and none, so far as I know, has been described that can be removed from the matrix practically perfect. Thus Heer in 1874 described *Ficus protogaea** from the Atane beds of Greenland, and in the Dakota group Lesquereux has found two fruits which he figures† without specific name. More recently Hollick has described and figured‡ another species as *F. neurocarpa* from the Dakota group of Ellsworth County, Kansas, and Cockerell§ has established a species (*F. Bruesi*) from the Miocene of Florissant, Colorado.

* Fl. Foss. Arc. 3^2: 108. *pl. 30. f. 5–7.* 1874.

† Mon. U. S. Geol. Surv. (Fl. Dak. Gr.) 19: 85. *pl. 10. f. 7, 8.* 1891.

‡ Bull. Torrey Club 30: 105. *f. 1.* 1903.

§ Torreya 10: 223. 1910. [Illust.]

No *Ficus* fruits have been before described from the Laramie or any of the related formations.

It is of course impossible to connect these fruits with leaves of *Ficus* in the same beds, though it is possible they may have belonged to a certain large-leaved species present.

OCCURRENCE: Lance formation ("Ceratops beds"), Lance Creek, Converse County, Wyoming. Collected by J. B. Hatcher, June 1881. Types in United States National Museum. Also found in the Lance formation ("Hell Creek beds") on Hell Creek, Montana, by Barnum Brown of the American Museum of Natural History, in which institution these specimens now are.

Ficus Russelli sp. nov.

Fruits similar to the preceding but in general much larger, with coarser, more prominent ribs.

It is perhaps doubtful if this should be considered as specifically distinct from the last. In manner of preservation and general appearance they are identical, but the largest example from Converse County scarcely reaches the size of the smallest specimen under consideration. Thus one of the smallest examples is about 3 cm. long and has a diameter of fully 2.5 cm., while the largest somewhat exceed a length of 4 cm. and a diameter of 3 cm. The pit or depression at the apex showing the point of entrance into the interior is perhaps more prominent and seemingly larger, but it must be confessed the differences are not great.

The material upon which this species is based, numbering between thirty and fifty very perfectly preserved specimens, was collected by Prof. I. C. Russell near Forsyth, Montana. The matrix is a shattered, calcareous sandstone and the fruits are imbedded at irregular distances and in all positions, and yet none is distorted in the least. Associated with the fruits are numerous fragmentary shells belonging to five or six species; and a few fragments of leaves were found in the same beds but unfortunately they are not determinable.

OCCURRENCE: Lance formation ("Ceratops beds"), Forsyth, Montana. Collected by I. C. Russell. Types in the United States National Museum.

U. S. NATIONAL MUSEUM,
WASHINGTON, D. C.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1909–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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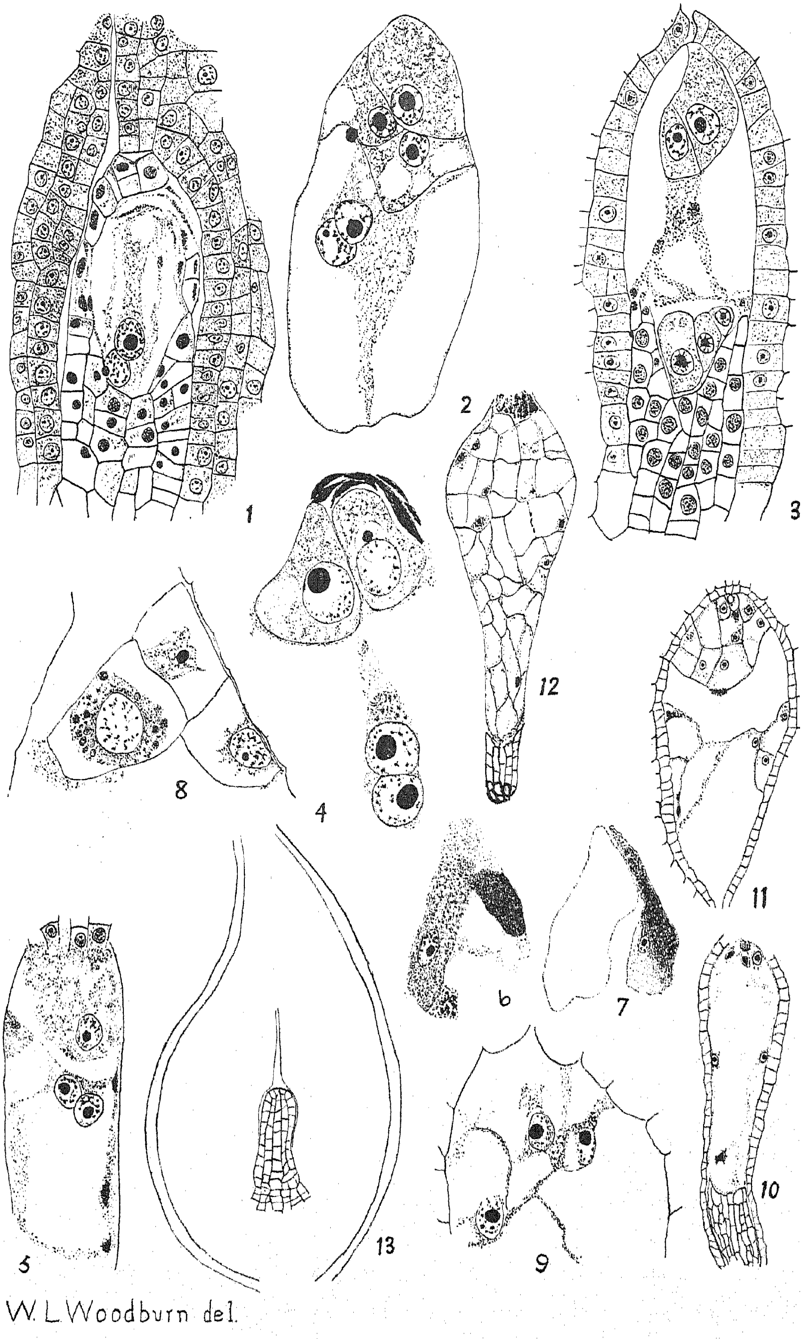

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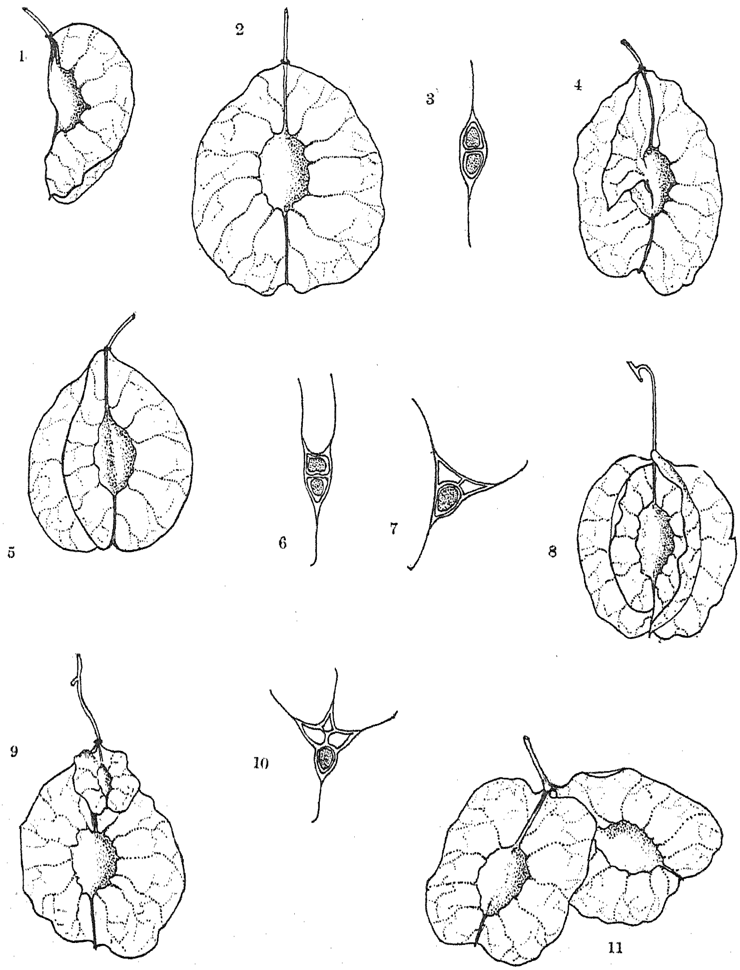

HARRIS, TERATOLOGICAL FRUITS OF PTELEA

Vol. 38 No. 9

BULLETIN

OF THE

TORREY BOTANICAL CLUB

SEPTEMBER, 1911

Contributions to the Mesozoic flora of the Atlantic coastal plain—VII

EDWARD W. BERRY

(WITH PLATES 18 AND 19)

The present contribution is a continuation of the author's previous studies upon the Upper Cretaceous floras of the Atlantic coastal plain and embraces additions to these floras from various localities and horizons extending from Raritan Bay in New Jersey to the Savannah River.

THE FLORA OF THE MATAWAN FORMATION

A considerable flora from the region around Keyport, New Jersey, was described by the writer nearly ten years ago. At that time these beds were included by geologists in the Matawan formation, but they have since been discriminated as a separate unit as far to the southwestward as the Potomac River under the name of the Magothy formation. This latter formation embraces all of those leafbearing beds in New Jersey which had previously been considered a part of the lower Matawan formation, leaving the restricted Matawan, which consists of strictly marine deposits, without any known flora. For this reason considerable interest is attached to the discovery in marine deposits of this age of the following identifiable species.

Ficus matawanensis sp. nov.

DESCRIPTION: Leaf oblong-lanceolate in outline, about 14 cm. to 15 cm. in length by 3.5 cm. in maximum width. Petiole short

[The BULLETIN for August 1911 (38: 351–398. *pl. 16, 17*) was issued 21 Au 1911.]

and very stout. Midrib very stout, prominent on the lower side of the leaf. Margins rather straight. Apex missing. Base pointed, slightly decurrent. Secondaries numerous, thin, regularly spaced, branching from the midrib at angles of about 50 degrees, running in an almost straight course to the vicinity of the margin, where their ends are united by flat arches. Tertiary venation as in the modern *Ficus elastica* Thunb. Texture very coriaceous. (PLATE 19, FIG. 3.)

The present species is very closely related to *Ficus reticulata* (Lesq.) Knowlton,* a species described originally from the Dakota sandstone of Kansas and reported by the writer from the Magothy formation of New Jersey. There are, however, slight differences in outline and in the details of the venation, which make it desirable to institute a new species. It shows also considerable similarity with a new species of *Ficus* to be described shortly by the writer from the Upper Cretaceous of Buena Vista, Georgia. The material, which is scanty, was collected from the Lorillard pits in the Woodbury clays by Dr. H. P. Little, a former student at the Johns Hopkins University. It was contained in a carbonate of iron nodule, such as are common in the dark micaceous shallow water clays at this point.

In addition to the foregoing species of *Ficus*, fragmentary leaves have been observed in similar nodules in the Matawan formation at Penny Hill, Delaware, and the following species has recently been collected from this horizon in Maryland.

DAMMARA CLIFFWOODENSIS Hollick

Dammara cliffwoodensis Hollick, Trans. N. Y. Acad. Sci. **16**: 128. *pl. 11. f. 5–8.* 1897.

These characteristic deciduous cone scales were described from the Magothy formation of New Jersey, where they are abundant. They are very similar to the somewhat earlier *Dammara borealis* Heer and furnish evidence of the substantial unity in floral characters between the Magothy and Matawan formations. The present occurrence is based on materials associated with waterworn fragments of lignite and marine invertebrates, ¾ mile east of Millersville, Anne Arundel County, Maryland.

* This name is preoccupied by *Ficus reticulata* Saporta, 1863, an Oligocene species of southeastern France, as well as by the living *F. reticulata* Thunb. 1786.

THE FLORA OF THE MAGOTHY FORMATION

Numerous contributions to the flora of the Magothy formation in New Jersey, Delaware, and Maryland have been made by the writer during the past few years. The last of these, published early in 1910, brought the total number of Magothy species reported from Maryland up to seventy-one. The following notes enumerate some recent additions to this flora, bringing the total number of recorded forms up to eighty-eight.

Algites americana sp. nov.

DESCRIPTION: Thallus, as preserved in the form of dichotomously divided branches, ranging in width from 2 mm. to 5 mm., thin and undulating as preserved, but rather coriaceous in life, with slightly wavy margins. These branches are not preserved for lengths of more than a few centimeters, during which intervals they are observed to divide but once or not at all. They have the appearance in some specimens of radiating from a common center, but as their proximal parts are invariably missing this supposition cannot be verified.

The Maryland remains are rare and are in the form of impressions along which recent rootlets have often permeated the argillaceous matrix, sometimes giving the specimens the appearance of having midribs. The North Carolina remains, which are abundant in the Black Creek beds at certain localities along the Black River, often show considerable carbonaceous residuum, indicating that in life the thallus was of considerable consistency.

OCCURRENCE: Severn River, Anne Arundel County, Md.

COLLECTIONS: U. S. National Museum.

ONOCLEA INQUIRENDA (Hollick) Hollick

Osmunda obergiana Heer, Fl. Foss. Arct. 3^2: 98 (in part). *pl. 26. f. 9d.* 1874.

Caulinites inquirendus Hollick, Bull. N. Y. Bot. Gard. 3: 406. *pl. 70. f. 3.* 1904.

Onoclea inquirenda Hollick, Mon. U. S. Geol. Surv. 50: 32. *pl. 1. f. 1-7.* 1907.

DESCRIPTION: Fragments of fertile fronds, not showing any lamina, which appears to be reduced to short pinnate branches bearing one or more spheroidal bodies interpreted as sori. These are uniformly 1.5 mm. or slightly less in diameter. (PLATE 18, FIG. 1, 1*a*.)

This species was originally described by Hollick (loc. cit.) and referred to the genus *Caulinites*, but was subsequently removed to the ferns because of its resemblance to the modern genus *Onoclea*, a resemblance that is close and not at all fanciful. Earlier figured forms of the same character were associated by Heer with his species *Osmunda obergiana* because they were found in the same beds with the fronds of this species although they were not found in organic union with the fronds. These fruits are much more like those of the modern forms of *Onoclea* than they are like those of *Osmunda*, and they are identical with those which are the type of the present species to which the writer has referred them.

The Long Island and Marthas Vineyard forms have these sori in a single row on each side of an axis, and some of the South Carolina specimens seem to have a similar arrangement, while others have them definitely in threes, one terminal and two lateral. This latter arrangement also prevails exclusively in the Greenland specimen and in similar material from the Magothy formation of Maryland. This variation is of minor importance and is mentioned simply because it is believed that the grouping in threes is the normal arrangement, which has been obscured during fossilization in the instances where it is not clear.

As here understood this species ranges from the Atane beds of Greenland southward in the Magothy formation of Marthas Vineyard, Long Island, and Maryland, to the Middendorf beds in South Carolina.

OCCURRENCE: Severn River, Anne Arundel County, Md.

GLEICHENIA SAUNDERSII Berry

Gleichenia Saundersii Berry, Amer. Nat. 37: 679. *f. 1–3.* 1903.

This small-pinnuled and coriaceous form was described originally from the Magothy formation of New Jersey, where it is present both on Raritan Bay and along the Delaware River. It has been recently discovered in the Magothy formation of Maryland, where at times the pinnules are rounded as shown in FIG. 2. This species resembles *Gleichenia gracilis* Heer, differing in the more numerous veins and their habit of forking. (PLATE 18, FIG. 2, 3, 3*a*.)

OCCURRENCE: Severn River, Anne Arundel County, Md.

Asplenium cecilensis sp. nov.

DESCRIPTION: Complete frond unknown. Pinnules linear-lanceolate, falcate, subopposite, united to the stout rachis by their entire bases, with entire margins and acute tips. The sterile pinnules are somewhat smaller than the fertile, being about 12 mm. or 13 mm. in length by 3 mm. in maximum width, which is at their base. They show a stout midrib which gives off about twenty-five branches on each side alternately above and below and is lost in the apical region by this repeated branching. These branches subtend a considerable angle and are recurved; they fork once near their base and run directly to the margin. The fertile pinnules are somewhat larger than the sterile, being of about the same length and slightly wider; they show stout midribs and the poorly preserved remains of numerous linear-lanceolate sori extending nearly from the midrib to the margin and obscuring the lateral veins, there being apparently a sorus to each forked lateral. (PLATE 18, FIG. 4, 5.)

This species greatly resembles various forms from the Upper Cretaceous of Greenland, which Professor Heer referred to the genus *Pteris*, the resemblance to *Pteris Albertsii* Heer being particularly marked. The latter is usually referred to the genus *Cladophlebis*, and this genus contains a number of forms that are comparable with *Asplenium cecilensis*. The fertile pinnules of the latter, imperfect as is their preservation, are clearly unlike those known in *Cladophlebis* and are clearly of a type allying this form with the Asplenieae.

OCCURRENCE: Grove Point, Cecil County, Md.

PODOZAMITES KNOWLTONI Berry

Podozamites Knowltoni Berry, Bull. Torrey Club 36: 247. 1909.

This well-known older Mesozoic species is common in the Upper Cretaceous of the coastal plain from New Jersey to South Carolina and also occurs in the Dakota sandstone of the West. It is present in recent collections from the Magothy formation in the vicinity of Round Bay on the Severn River in Anne Arundel County, Md.

Protophyllocladus lobatus sp. nov.

Thinnfeldia sp. nov., Berry, Johns Hopkins Univ. Circ. II. 7: 81. 1907.

DESCRIPTION: Leaves (phylloclads) of large size, lanceolate or oval in general outline, either entire with crenate margins, rounded

apex, and narrowly cuneate base or compound through the development of opposite lateral lobes. Axial vascular strand very stout below, becoming very thin and finally disappearing apically. When lobate, subordinate opposite vascular strands form the axis of the lobes, and these are usually but not always lost before reaching the tips of the lobes by giving off innumerable secondary branches. Margins are in all cases rather remotely undulate-crenate and the tips are all rounded. Secondaries numerous and thin, diverging from the main axis of the phylloclad on the axis of the lobes at very acute angles, curving outward, either simple, more often dichotomously forked, and occasionally several times forked. Lobes when present separated by cuneate narrowly rounded sinuses which terminate some distance from the main axis. The largest specimen, which is still incomplete at both the apex and the base, measures 8 cm. in length and 5 cm. from tip to tip of the lower lobes, the upper entire portion measuring about 1.5 cm. in width.

These remains are superficially like fern fronds, especially in specimens that are compound, and were it not for the presence in the Cretaceous of other *Phyllocladus*-like remains with a demonstrated gymnospermous structure (e. g., *Androvettia*) their reference to this genus would seem hazardous. The entire specimens are strikingly like some of the forms of *Protophyllocladus subintegrifolius* (Lesq.) Berry of the Raritan and Magothy formations, or like *Protophyllocladus polymorphus* (Lesq.) Berry from higher western American horizons, and even the compound specimens have an unlobed apical portion of comparable length which is also similar in appearance to the two species just mentioned. The compound forms are superficially like *Thinnfeldia rhomboidalis* Ettings.,* the type of the genus *Thinnfeldia*, whose systematic position has been the occasion of so much controversy and which has been variously regarded as a fern, a cycad, or a conifer. The present species shows important differences, however, aside from its much younger age, and it is confidently believed to be unrelated to the various older Mesozoic species of *Thinnfeldia* that have been described.

It may also be compared with various forms from the Upper Cretaceous of Dalmatia which were discussed at great length by Kerner,† who refers them to the genus *Pachypteris*. This he

* Ettings. Abhl. Geol. Reichsanstalt 3: 2. *pl. i. f. 4–7.* 1852.

† Kerner, Jahrb. Geol. Reichsanstalt 45: 39. 1896.

regards as cycadaceous in nature, but it is believed to be closest to *Protophyllocladus subintegrifolius*, a species that is abundant in the Atane beds of Greenland, the Dakota group of Kansas and Nebraska, the Raritan of New Jersey, and the Magothy from Marthas Vineyard to New Jersey, and which often assumes a sublobate form. This is especially shown in unreported collections made by the writer in the Magothy formation of New Jersey.

The present species is found in the Magothy formation of Maryland and is frequent in the Middendorf beds of South Carolina. The latter occurrences will be fully described and illustrated in a forthcoming report of the U. S. Geological Survey.

OCCURRENCE: Sullivans Cove, Severn River, Anne Arundel County, Md.

(?) ARAUCARIA BLADENENSIS Berry

Araucaria bladenensis Berry, Bull. Torrey Club 35: 225. *pl. 12–14. f. 1–3.* 1908.

This species is highly characteristic of the Black Creek and lower Eutaw horizons of the southern coastal plain and is very abundant in North Carolina and along the Chattahoochee River in Georgia, occurring also in central Alabama. It is represented in the Magothy formation of New Jersey by *Araucarites ovatus* Hollick. There is a single well marked leaf of an *Araucaria* in the collections from Grove Point, Cecil County, Maryland, which is very close to *Araucaria bladenensis*, but which I have queried since the material is so scanty that it might possibly represent a small leaf of the normally larger *Araucarites ovatus*.

Sabalites magothiensis (Berry) nom. nov.

Flabellaria magothiensis Berry, Torreya 5: 32. *f. 1, 2.* 1905.

Since the name *Flabellaria* as the designation of a genus of fossil palms (Sternberg, 1820) is preoccupied by Cavanille's monotypic recent genus *Flabellaria* of the family Malpighiaceae, described in 1790, this species is referred to the form genus *Sabalites*, which is an equally appropriate repository for flabellate, Sabal-like, fossil palm leaves of uncertain botanical affinities.

PISTIA NORDENSKIOLDI (Heer) Berry

Pistia Nordenskioldi Berry, Bull. Torrey Club 37: 189. *pl. 21. f. 1–15.* 1910.

This well marked type, which was described originally by Professor Heer from the Atane beds of Greenland as a species of *Chondrophyllum*, and which was found to be exceedingly common in the Black Creek beds of North Carolina, is present in the Magothy formation at Grove Point, Cecil County, Md.

Doryanthites cretacea gen. et sp. nov.

Leaves, as preserved, linear, presumably lanceolate above and sheathing below, alike on both surfaces, 4.5 cm. to 6 cm. wide and preserved without any diminution in width for a length of 50 cm. Texture very coriaceous. Margins entire. Veins simple and parallel, immersed, less than 1 mm. apart. Stomata poorly preserved, in rows in hollows between the veins.

These curious forms, which will be more fully characterized and figured in monographs on the North Carolina and Georgia floras now in course of publication, call to mind the larger forms of *Cordaites* or some modern giant bromeliad. They are monocotyledons of unknown botanical affinity, and the name chosen is based upon their similarity with the modern genus *Doryanthes* of the Liliales and is without any significance of relationship.

The present species is abundant and characteristic in the Black Creek formation of North Carolina, the Cusseta sands of Georgia, and the lower Eutaw of Alabama. It is probably represented in the Magothy formation of New Jersey by the forms from Cliffwood bluff which have been identified as *Podozamites marginatus* Heer. In the Maryland Magothy *Doryanthites cretacea* occurs at Sullivans Cove and other adjacent localities along the Severn River in Anne Arundel County.

MAGNOLIA CAPELLINII Heer

Magnolia Capellinii Heer, Phyll. Crét. Nebr. 21. *pl.* 3. *f.* 5, 6. 1866.

This well-known species, which characterizes the Magothy formation of the northern coastal plain, the Black Creek beds of North Carolina, and the Tuscaloosa formation of Alabama, occurs in the Magothy formation of Maryland at Grove Point in Cecil County, and at Sullivans Cove on the Severn River in Anne Arundel County.

COLUTEA PRIMORDIALIS Heer

Colutea primordialis Heer, Fl. Foss. Arct. 6^2: 99. *pl. 27. f. 7–11; pl. 43. f. 7, 8.* 1882.

This well marked little species was described from the Atane beds of Greenland. It occurs in strata at least as old as the upper Raritan in New Jersey and is present in both the Dakota and Magothy floras. It is present in the collections from Grove Point, Cecil County, Maryland, where it is associated with *Colutea obovata* Berry.

Dalbergia severnensis sp. nov.

DESCRIPTION: Leaves of rather small size, oblanceolate in general outline, with a markedly emarginate apex, gently curved sides, and narrowly pointed base. Length about 5 cm. Maximum width about 1.5 cm. in the middle part of the leaf. Midrib stout below, thin above. Secondaries five or six pairs, branching from the midrib at angles of 45 degrees or less, the lower ascending, the upper curved, all eventually camptodrome.

This handsome form, which is clearly distinct from any previously described species, is identical in its characters with the forms usually referred to *Dalbergia*. (PLATE 19, FIG. 2.)

OCCURRENCE: Little Round Bay, Severn River, Anne Arundel County, Md.

Ilex severnensis sp. nov.

DESCRIPTION: Leaves of small size, oblong in general outline, with a cuspidate apex and a narrowly rounded base. Length about 2 cm. Maximum width about 6.5 mm. Texture coriaceous. Margin entire below; above, with a few irregularly spaced salient serrate teeth. Midrib relatively stout. Secondary venation thin and more or less obsolete, consisting of a vein which forms a marginal hem all around and numerous transverse veins between it and the midrib. The latter are for the most part nearly straight, diverging from the midrib at angles of about 90 degrees, giving the leaf a scalariform appearance, as shown in the enlarged figure of this form. (PLATE 19, FIG. 1, 1*a*.)

This small species is clearly new and is closely allied to various species of *Ilex*.

OCCURRENCE: Little Round Bay, Severn River, Anne Arundel County, Md.

CELASTRUS ARCTICA Heer

Celastrus arctica Heer, Fl. Foss. Arct. 7: 40. *pl. 61. f. 5d, e.* 1883.

This extremely well marked species was described by Heer

from the Patoot beds of Greenland. It was subsequently found to be exceedingly abundant in the uppermost Raritan beds of New Jersey* and it has been recorded from this same horizon on Long Island as well as from a probable Magothy horizon on Block Island. It has been recently found in considerable abundance near the top of the Magothy formation at Little Round Bay on the Severn River in Anne Arundel County, Md.

ARALIA GROENLANDICA Heer

Aralia groenlandica Heer, Fl. Foss. Arct. 6^2: 84. *pl. 38. f. 3; pl. 39. f. 1; pl. 46. f. 16, 17.* 1882.

This somewhat poorly defined species of the Atane, Dakota, and Magothy formations is present in the collections from Sullivans Cove on the Severn River in Anne Arundel County, Md.

Cornus cecilensis sp. nov.

DESCRIPTION: Leaves of medium size, broadly ovate in outline, 8.5 cm. in length by 4.75 cm. in maximum width at a point about halfway between the apex and the base. Apex bluntly pointed. Base cuneate. Midrib stout. Secondaries about six pairs, branching from the midrib at angles of about 45 degrees, curving upward approximately parallel with the margin, at length camptodrome. (PLATE 19, FIG. 4.)

This new species is broader and more elliptical in outline than any previously known Cretaceous species of *Cornus*. It is contained in collections from Grove Point in Cecil County, Md.

MYRSINE GAUDINI (Lesq.) Berry

Myrsine Gaudini Berry, Bull. Torrey Club **36**: 262. 1909.

This species has been recorded from a number of widely scattered areas in the Raritan, Magothy, Black Creek, and Tuscaloosa floras of the coastal plain from Long Island to Alabama, and also from the Dakota sandstone of Kansas. The present occurrence is at Grove Point in Cecil County, Md.

THE RARITAN FLORA OF MARYLAND

No fossil plants have been specifically recorded from the Raritan formation in the state of Maryland although this horizon

* Newberry, Fl. Amboy Clays 98. *pl. 13. f. 8–18.* 1896.

has yielded a large and diverse flora in New Jersey, the bulk of which comes from the clay beds of the Amboy district in Middlesex County.

In Maryland the Raritan is much more sandy than to the northeastward, and while fragments of vegetation are widely distributed, identifiable remains are rare and extremely local. From a locality in the District of Columbia known as Pennsylvania Avenue extended, which has the same outcrop as that referred to in the present paper as East Washington Heights, the following forms have been enumerated: *Aralia washingtoniana* Berry, *Platanus Heerii* Lesq., *Salix Lesquereuxii* Berry, *Sassafras acutilobum* Lesq., and *Sassafras cretaceum* Newb. These were recorded in a previous paper devoted to the flora of the Magothy formation,* to which horizon they were referred. Upon examination this outcrop proves to be in the Raritan formation, and several additional species have been discovered from it.

ASPLENIUM DICKSONIANUM Heer

Asplenium Dicksonianum Heer, Fl. Foss. Arct. 3^2: 31. *pl. 1. f. 1–5.* 1874.

This late Lower and early Upper Cretaceous fern has been recorded from a variety of horizons and localities and has no doubt been confused with other fern genera, as for example *Onychiopsis* (*Thyrsopteris* of Fontaine). It is abundant in the New Jersey Raritan,† and forms identical with the New Jersey material are present at Shannon Hill in Cecil County, Maryland, and at East Washington Heights in the District of Columbia.

Cladophlebis socialis (Heer)

Pecopteris socialis Heer, Fl. Foss. Arct. 6^2: *pl. 7. f. 4; pl. 8. f. 15; pl. 32. f. 9.* 1882 (not Fontaine).

The present species was described by Professor Heer from the Atane beds of western Greenland. Subsequently Fontaine identified as this species a very different form from the Patapsco formation of Virginia, a form that I have referred to *Cladophlebis Browniana* (Dunker) Seward.

Remains identical with Heer's type, which I refer to the form

* Berry, Bull. Torrey Club 37: 19–29. 1910.

† Newberry, Fl. Amboy Clays 39. *pl. 1. f. 6, 7; pl. 2. f. 1–8; pl. 3. f. 3.* 1896.

genus *Cladophlebis*, are contained in the Raritan material from Shannon Hill, Cecil County, Md.

PODOZAMITES LANCEOLATUS (L. & H.) F. Braun

Podozamites lanceolatus F. Braun in Münster, Beitr. Petrefaktenkunde **2**: 33. 1843.

This possibly composite species, which has a recorded range from the Jurassic to the Upper Cretaceous, occurs in the Raritan collections from Shannon Hill, Cecil County, Md. It is present in the underlying Patapsco formation and in the overlying Magothy formation in the Maryland area and is of slight stratigraphic significance.

PODOZAMITES MARGINATUS Heer

Podozamites marginatus Heer, Fl. Foss. Arct. 6^2: 43. *pl. 16. f. 10.* 1882.

The type of this species was described by Heer from the Atane beds of western Greenland. Subsequently Newberry* reported abundant fragmentary remains of this species from the middle Raritan deposits of New Jersey. The writer has recorded it from the Magothy formation of New Jersey but this identification is probably erroneous.

What appear to be leaflets of this species are present in collections from the Raritan formation of Maryland at the locality on the Drum Point R. R. near the head of the Severn River in Anne Arundel County.

FICUS OVATIFOLIA Berry

Ficus ovata Newb., Mon. U. S. Geol. Surv. **26**: 70. *pl. 24. f. 1–3.* 1896 (not Don, 1803).

Ficus ovatifolia Berry, Bull. Torrey Club **36**: 253. 1909.

This species, which is close to and probably the ancestral form of *Ficus Woolsoni* Newb., is sparingly represented in the Raritan formation at East Washington Heights, District of Columbia.

ASPIDIOPHYLLUM TRILOBATUM Lesq.

Aspidiophyllum trilobatum Lesq. Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) **1874**: 361. *pl. 2. f. 1, 2.* 1876.

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* Newberry, Fl. Amboy Clays 44. *pl. 13. f. 5, 6.* 1896.

This remarkable species was described from the Dakota sandstone of Kansas, to which horizon it has hitherto been confined. It is present at a number of Maryland Raritan localities in considerable abundance although for the most part in a rather fragmentary condition.

OCCURRENCE: Shannon Hill, Cecil County; Riverside Brick Co., Anne Arundel County; East Washington Heights, District of Columbia.

PROTOPHYLLUM MULTINERVE Lesq.

Protophyllum multinerve Lesq. Fl. Dakota Group 191. *pl. 43. f. 2; pl. 65. f. 1.* 1892.

This species was described from the Dakota sandstone in 1872 as a species of *Pterospermites*.* It has not been hitherto recorded outside of this horizon in Kansas. It is common in the Raritan clays at Cedar Point in Baltimore County, and less abundantly represented at East Washington Heights, District of Columbia.

PROTOPHYLLUM STERNBERGII Lesq.

Protophyllum Sternbergii Lesq. Fl. Dakota Group 189. *pl. 142. f. 1.* 1892.

This species, like the preceding, has not heretofore been found outside the Dakota sandstone of the West, from which it was described originally as a species of *Pterospermites*.† It is found to be not uncommon in the Maryland Raritan and is represented in collections from Shannon Hill and Bull Mountain in Cecil County, and from East Washington Heights in the District of Columbia.

PLATANUS HEERII Lesq.

Platanus Heerii Lesq. Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) 1871: 303. 1872 (not Ward).

Sassafras recurvatus Lesq. Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) 1872: 424. 1873 (not Heer 1882).

Platanus Heerii Lesq. Cret. Fl. 70. *pl. 8. f. 4; pl. 9. f. 1, 2.* 1874.

Platanus recurvata Lesq. ibid. 71. *pl. 10. f. 4, 5.* (not *f. 3*).

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* Lesq. Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) 1871: 302. 1872.

† Lesq. Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) 1872: 425. 1873.

(?) *Platanus Heerii* Lesq. Rept. on Clays in N. J. 29. 1878.
Platanus Heerii Heer, Fl. Foss. Arct. 6^2: 72. *pl. 7. f. 1, 2; pl. 8. f. 1, 2a; pl. 9. f. 1–4.* 1882.
(?) *Platanus Heerii* Lesq. Cret. and Tert. Fl. 44. *pl. 3. f. 1; pl. 7. f. 5.* 1883.
Sassafras (Araliopsis) recurvatum Lesq. ibid. 57 (part). 1883.
Sassafras cretaceum recurvatum Berry, Bot. Gaz. 34: 438. 1902.
Platanus Heerii Berry, Bull. Torrey Club 37: 23. 1910.

DESCRIPTION: Leaves broadly rhomboidal in outline, more or less trilobate. Lobes, when developed, short and obtuse. Base decurrent. Petiole long and stout. Margin sublobate, undulate or irregularly dentate. Texture coriaceous. Primaries three, stout, diverging at acute angles. The lateral primaries are as stout as the midrib from which they branch in an opposite or subopposite position, either from the extreme base or a considerable distance above the base. In the latter case there is often a prominent secondary given off from the midrib on either side below the primaries. The primaries may give off a few rather long straight craspedodrome secondaries to the rather full lateral margin or they may send off a stout lateral branch at varying distances above the base. Secondaries from the midrib few in number, stout, irregularly spaced, craspedodrome. Tertiaries transverse, platanoid.

This species was described from the Dakota sandstone of Kansas by Professor Lesquereux, in 1872, who subsequently in his Cretaceous Flora confused it with *Platanus* or *Sassafras recurvatum*. The latter, if it really designates a species, must be restricted to the form figured by Lesquereux on *plate 10, fig. 3* of the Cretaceous Flora, which is decidedly different from his other figures on that plate. The latter are leaves of *Platanus Heerii* while the former must be referred to *Sassafras cretaceum* or *mirabile*. Not only is it distinctly trilobate but the margin is entire and the venation camptodrome, while in the leaves of *Platanus Heerii* on the same plate the form and margin are different and the venation is craspedodrome. Professor Heer correctly identified *Platanus Heerii* from the Atane beds of Greenland, and the forms which he figured from these beds as *Sassafras recurvatum* are distinct from *Platanus Heerii* and resemble Lesquereux's *fig. 3* mentioned above. The writer, some years ago (1902, loc. cit.) in discussing *Sassafras recurvatum*, pointed out the composite nature of this form and

suggested that those forms which are here referred to *Platanus Heerii* were referable to *Platanus*, while the other type was comparable with *Sassafras cretaceum* or *mirabile*.

Professor Ward, in 1887,* after sending figures of some leaves which he had collected at Black Buttes, Wyoming (a probably basal Eocene locality), to Lesquereux, who insisted that they were not *Platanus Heerii*, persisted in identifying them as this species although they are obviously not closely related to it.

Platanus Heerii was identified by Lesquereux from the New Jersey Raritan in collections made from Pettit's pits, South River, but as the material was poor and the species has not since been detected in the New Jersey Raritan this occurrence is usually ignored, although the abundance of this species in the Raritan of Maryland renders its presence in New Jersey probable. In the Maryland Raritan, fragments of this species are very common but they are usually in a bad state of preservation. The species extends northward to the west coast of Greenland and it shows considerable resemblance to *Credneria rhomboidea*, described by Velenovsky from the Cenomanian of Bohemia.†

OCCURRENCE: Drum Point R. R. near head of Severn River, Anne Arundel County, Md.; East Washington Heights, District of Columbia.

COLLECTIONS: Maryland Geological Survey, U. S. National Museum.

Araliopsis gen. nov.

The name *Araliopsis* was used by Professor Lesquereux as the designation for a group of forms which he described under *Sassafras*.

Since these species are not allied to *Sassafras* and show numerous characters that ally them with the Araliaceae their segregation is warranted. *Araliopsis* becomes, then, a form genus for certain araliaceous leaves that cannot be identified with any of the known genera with any degree of certainty.

Araliopsis cretacea (Newberry)

Sassafras cretaceum Newb. Ann. N. Y. Lyc. Nat. Hist. **9**: 14. 1868 (not Penhallow, 1904 and 1908). Ill. Cret. and Tert.

* Ward, Bull. U. S. Geol. Surv. 37: 34. *pl. 15. f. 3, 4.* 1887.

† Velenovsky, Fl. Böhm. Kreidef. **1**: 11. *pl. 3. f. 2, 3; pl. 4. f. 1.* 1882.

Pl. *pl. 6. f. 1–4.* 1878. Mon. U. S. Geol. Surv. **35**: 98. *pl. 6. f. 1–4; pl. 8. f. 1, 2* (not *pl. 7. f. 1–3*). 1898. Lesquereux, Cret. Fl. 80. *pl. 11. f. 1, 2; pl. 12. f. 2.* 1878. ?Kurtz, Revista Mus. La Plata **10**. 1902. Berry, Bot. Gaz. **34**: 444. 1902.

DESCRIPTION: "Leaves petiolate, decurrent at base, very smooth above, strongly nerved below; three-lobed; lobes entire and acute. The nervation is all strongly defined; the central nerve straight or nearly so; the lateral primary nerves springing straight outward till they approach the margin of the lobes, when they are abruptly curved and run together. From these the tertiary nerves are given off at a right angle, and from these the quaternary nerves spring at a similar angle, together forming a network of which the areoles are subquadrate." Newberry, 1868.

Professor Newberry includes under *Sassafras cretaceum* the various forms described by Professor Lesquereux as *S. Mudgei*, *S. subintegrifolium*, *S. integrifolium*, *S. obtusum*, *S. cretaceum dentatum*, *S. cretaceum obtusum*, *S. acutilobum*, *Cissites Harkerianus*, and *C. salisburiaefolius*. While this shows the undoubted composite nature of *S. cretaceum*, it shows also that the extremes of leaf form above mentioned are so closely connected with the more typical leaf by a series of intermediate forms that the question of where one species shall end and another begin is an extremely difficult one.

The writer considers the leaf figured on *pl. 6. fig. 1*, Later Ext. Fl., to be the typical form of this species, thus agreeing with Newberry's original description and with his later opinion expressed in 1898. This type bears considerable resemblance to some modern *Sassafras* leaves. A slight widening of the terminal lobe of some of these in the basal region would give a leaf strikingly like *S. cretaceum;* or, were the sinuses of the latter slightly deeper we would have the typical modern leaf. The basal portion of the leaf is like *Sassafras*, and the indications point to a similar venation in this region. The first pair of secondaries do not branch to form margins of the sinuses; the left one runs directly to the sinus, however, and may possibly have conformed to the margin and been effaced in the specimen; the right one is stronger and runs almost to the sinus, where it makes a sharp turn upward, continuing until it joins the next secondary. This feature is

analogous to those in the modern leaf, which may indicate the mode of origin of this peculiar character. This leaf seems to form a central figure from which a series of forms grade in several directions, culminating in quite dissimilar leaves. Lesquereux's *S. cretaceum* is a more Platanoid leaf, with more acute tips, a tendency to become dentate, and with the primaries inserted nearer the base. Closely allied to the preceding is his *S.* (*Araliopsis*) *mirabile*, which serves as a connecting link with his *Platanus recurvata*. From the aforementioned *S. cretaceum* of Lesquereux it is but a step to such a leaf as the one shown on *pl. 8. fig. 2*, Later Ext. Fl., and to the trilobed forms referred to *Cissites Harkerianus*, and these in turn grade into the more Cissoid forms of this species, such as those shown on *pl. 11. fig. 3*, Cret. Fl. The primaries are basal and of not much greater caliber than the regularly succeeding straight secondaries. It is but a step from this leaf to that of *Cissites Heerii* on the one hand, with its palmately five-pointed blade; and to such forms as *Cissites acuminatus*, *pl. 5*, *fig. 4*, Cret. and Tert. Fl., on the other; which in turn, by the elimination of the decreasing dentate points, gives us the leaf figured as *3*, *pl. 5*, Cret. and Tert. Fl. In the second series of leaves diverging from the typical, *S. cretaceum*, *pl. 8*, *fig. 1*, Later Ext. Fl., is removed a slight distance by the shortening of the blade, the thickening of the primaries and secondaries, and the shortening and rounding of the lobes (*S. obtusum*); while a smaller leaf would be its logical descendant; and from these leaves to those referred to the typical *Cissites salisburiaefolius* is but a step. In the third series of leaves diverging from the typical *S. cretaceum*, we note that the leaf has its lobes much produced, narrow and running to a sharp point, as in the beautiful leaf on *pl. 7. fig. 1*, Later Ext. Fl., which however is still referred to *S. cretaceum*. Lesquereux's *S. acutilobum* does not differ greatly from the preceding except in the direction of the lobes, which is a questionable specific character. From this leaf there is no great jump to those trilobed forms which are referred to *Aralia Wellingtoniana*, the chief difference being in the margin. Thus we have an interrelated series connecting those leaves which seem to show affinity to *Sassafras* with those which suggest *Platanus*, and with others that suggest *Cissites* and *Aralia*.

While it may be considered probable that from a biologic viewpoint the forms mentioned in the foregoing paragraphs, as well as others not cited, represent the variations of a single species of Upper Cretaceous tree, or at least represent the leaves of closely affiliated species, it seems best from the viewpoint of systematic, and especially stratigraphic, paleobotany, that most of the differentiations instituted by Lesquereux be perpetuated. Consequently the present species is limited to the typical material as defined and illustrated by the original describer.

Falling within these limits are a number of unrecorded specimens occurring in the Raritan formation of Maryland.

OCCURRENCE: Bull Mountain and Shannon Hill, Cecil County, Md.; East Washington Heights, District of Columbia.

COLLECTIONS: Maryland Geological Survey, U. S. National Museum.

Araliopsis cretacea dentata (Lesq.)

Sassafras (Araliopsis) cretaceum dentatum Lesq. Ann. Rept. U. S. Geol. and Geogr. Surv. Terr. **1874**: 344. 1876. Cret. Fl. *pl. 11. f. 1, 2.*

DESCRIPTION: This variety may be distinguished from the type by its usually smaller size and by its dentate margin.

OCCURRENCE: A characteristic specimen is present in the collections from the Raritan formation at Bull Mountain, Cecil County, Md.

Araliopsis cretacea salisburiaefolia (Lesq.)

Populites salisburiaefolia Lesq. Amer. Jour. Sci. II. **46**: 94. 1868.
Sassafras obtusus Lesq. Fifth Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) **1871**: 303. 1872.
Sassafras obtusus Lesq. Sixth Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) **1872**: 424. 1873.
Sassafras obtusum Lesq. Cret. Fl. 81. *pl. 13. f. 2–4.* 1874.
Sassafras (Araliopsis) cretaceum obtusum Lesq. Cret. Fl. 80. *pl. 12. f. 3; pl. 13. f. 1.* 1874. Mon. U. S. Geol. Surv. **17**: 102. 1892.
Cissites obtusum Lesq. Eighth Ann. Rept. U. S. Geol. Surv. Terr. (Hayden) **1874**: 354. 1876.
Sassafras (Araliopsis) obtusum Lesq. Cret. and Tert. Fl. 56. 1883.
Cissites salisburiaefolius Lesq. Cret. and Tert. Fl. 66. 1883.

Cissites salisburiaefolius Lesq. Mon. U. S. Geol. Surv. 17: 164. 1892.

(?) *Sassafras cretaceum* Newb. Mon. U. S. Geol. Surv. 35: *pl. 8. f. 1.* 1898.

Cissites salisburiaefolius Ward, Nineteenth Ann. Rept. U. S. Geol. Surv. Pt. 2: 707. *pl. 171. f. 5.* 1899.

Typical specimens of this well marked and handsome variety, which is possibly a distinct species, are common in the Raritan formation at Bull Mountain, Cecil County, Md.

Araliopsis breviloba sp. nov.

DESCRIPTION: Leaves of medium size, fanshaped in general outline, between 10 cm. and 11 cm. in length by the same dimensions in maximum width, which is from tip to tip of the lateral lobes. Trilobate. Apical lobe very short and conical. Lateral lobes short and pointed, somewhat recurved outward. Sinuses open, shallow and rounded, not extending more than one fifth of the distance from the apex to the base. Lateral margins at first full and rounded, then curving inward to the decurrent base. Primaries three in number, all equally stout and curved, the laterals subopposite and suprabasilar. Secondaries numerous, curved, camptodrome, branching from the primaries at angles of less than 45 degrees. Tertiaries transverse. Margins entire throughout. Texture coriaceous.

This characteristic leaf is probably the end term of a series of forms starting with *Araliopsis cretacea*, but whether it represents an extreme of variation of that species or a distinct but related species cannot now be definitely determined. The present form suggests various species from the Dakota sandstone of the West, which Professor Lesquereux referred to the genus *Cissites*. It is also similar to the form from the Cenomanian of Bohemia described by Velenovsky* as *Aralia anisiloba*, differing slightly in outline and lacking the remotely dentate margins of the latter.

OCCURRENCE: Bull Mountain, Cecil County, Md.

COLLECTIONS: Maryland Geological Survey.

DIOSPYROS PRIMAEVA Heer

Diospyros primaeva Heer, Phyll. Crét. Nebr. 19. *pl. 1. f. 6, 7.* 1866.

This well characterized species was described from the Dakota

* Velenovsky, Fl. Böhm. Kreidef. 1: 22. *pl. 5. f. 4–6.* 1882.

sandstone in 1866 by Professor Heer. It was subsequently detected in western Greenland by the same author and has been found to be abundant in the coastal plain from Marthas Vineyard to Texas. It is especially abundant in the upper Raritan at South Amboy, New Jersey, and is found in the Maryland Raritan at Bull Mountain in Cecil County.

Diospyros vera sp. nov.

DESCRIPTION: Calyx small, four-parted, 11.5 mm. in diameter from tip to tip of the lobes, which are obtusely pointed and nearly orbicular in outline, about 4 mm. or 5 mm. in width, contracted proximad and somewhat reflexed, coriaceous, longitudinally veined, with inflexed margins, which gives them a spoonlike form. Sinuses rather narrow and pointed, extending two thirds of the distance to the peduncle. The central disk of the calyx appears flat. There is a raised collar at the insertion of the peduncle, the latter from its scar appearing to have been relatively slender. (PLATE 19, FIG. 5.)

The present species is based upon the single specimen figured, which shows the lower, peduncular face of the calyx. It is clearly referable to this genus and the calyx was probably accrescent as in the modern forms. It is much smaller than in our common American *Diospyros virginiana* L., but may be matched in some of the still existing species and is almost the exact counterpart of some of the calices of *Diospyros brachysepala* A. Br., figured by Heer from the Swiss Tertiary. There can be no question regarding its identity and in this respect it is much more conclusive than the *Calycites diospyriformis* described by Newberry from the middle Raritan of New Jersey, which has a five-lobed calyx. Its occurrence at the same horizon in which the leaves of *Diospyros primaeva* Heer are so abundant not only suggests that it may have been borne by the same tree that furnishes the leaves found all the way from western Greenland to Alabama, but also serves in a measure to corroborate the identification of these leaves.

The family Ebenaceae has only five modern genera but these include a large number of species, a majority of which are referred to the genus *Diospyros*. The latter has about 180 existing species distributed in both hemispheres. They are mostly tropical, a few species extending beyond the tropics in eastern North America,

the Mediterranean region of Eurasia, and in eastern Asia, where there is a considerable massing of forms.

OCCURRENCE: East Washington Heights, District of Columbia.

COLLECTIONS: U. S. National Museum.

UPPER CRETACEOUS FLORA OF SOUTH CAROLINA*

Although several localities in the State of South Carolina are mentioned in Vanuxem's paper† announcing the presence of deposits of Cretaceous age in North America, these were all marine fossiliferous beds, and no deposits of this age are mentioned in Prof. Lester F. Ward's exhaustive paper on The Geographical Distribution of Fossil Plants, published in 1889. That fossil plants were not entirely unknown, however, is shown by the mention of several localities in Tuomey's Geology of South Carolina, published in 1848. In recent years Mr. Earle Sloan, State Geologist of South Carolina, has discovered several plant-bearing outcrops, and during the progress of the work upon which the following notes are based various collections have been made by the latter as well as by Dr. L. W. Stephenson and the writer. Collections were also made by Professors L. F. Ward and L. C. Glenn in 1897, and these also have been studied by the writer.

The Upper Cretaceous of South Carolina, which is the only known leaf-bearing Cretaceous, overlies unconformably the Lower Cretaceous, which forms a belt of varying width extending entirely across the state along the southeastern border of the Piedmont Plateau. These Upper Cretaceous deposits assume two more or less distinct lithological phases, in part contemporaneous, and dependent for the most part upon the physical conditions accompanying their deposition. The initial Upper Cretaceous deposition has been termed the Middendorf member and includes the littoral, estuarine, and shallow water phase of deposition at the commencement of the transgression of the Upper Cretaceous sea. These soon pass gradually into deeper but still shallow water deposits of sands and dark carbonaceous laminated clays, which have received the name of Black Creek beds. The latter are especially well developed in the northeastern part of the coastal plain of

* Published by permission of the Director of the U. S. Geological Survey.

† Vanuxem, L. Jour. Acad. Nat. Sci. Phila. 6: 59–71. 1829.

South Carolina, being replaced to the southwestward by sands and kaolins marking a continuance of the Middendorf phase for a much longer time in that area than to the northeastward. Both phases finally pass gradually into typical marine, non-plant-bearing beds. Eleven localities within the state are known to bear fossil plants. Five of these are in the Middendorf and six are in the Black Creek, and these will be fully described in the final report on this flora.

Seventy-six different species of fossil plants have been determined from these various outcrops. Twenty-four of these are new to science. The latter are referred to the following genera:

Acaciaphyllites
Algites
Andromeda
Araucaria
Calycites
Celastrophyllum
Cinnamomum
Crotonophyllum
Ficus
Heterolepis
Illicium
Leguminosites
*Lycopodium**
Momisia
? *Pachistima*
Potamogeton
Proteoides
Protophyllocladus
Quercus (2 species)
Rhus
Salix
Strobilites

The following heretofore described species have been identified in the South Carolina collections:

Andromeda grandifolia Berry
Andromeda Novae-caesareae Hollick
Andromeda Parlatorii Heer
Araucaria bladenensis Berry
Araucaria Jeffreyi Berry
(?) *Arundo groenlandica* Heer
Brachyphyllum macrocarpum Newb.
Carex Clarkii Berry
Celastrophyllum crenatum Heer
Celastrophyllum elegans Berry
Cephalotaxospermum carolinianum Berry
Cinnamomum Newberryi Berry
Citrophyllum aligerum (Lesq.) Berry
Dewalquea Smithi Berry
Diospyros primaeva Heer
Diospyros rotundifolia Lesq.
Juglans arctica Heer
Laurus atanensis Berry† nom. nov.
Laurus plutonia Heer
Laurophyllum elegans Hollick
Laurophyllum nervillosum Hollick
Leguminosites robiniifolia Berry
Magnolia Capellinii Heer
(?) *Magnolia Newberryi* Berry
Magnolia obtusata Heer
(?) *Magnolia tenuifolia* Lesq.
Moriconia americana Berry
Myrica Brittoniana Berry
Myrica elegans Berry
Myrsine Gaudini (Lesq.) Berry
Onoclea inquirenda Hollick
Phragmites Pratti Berry

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* This species is described in Amer. Jour. Sci. IV. 30: 275, 276. 1910.

† This is a new name proposed for the well-known species *Laurus angusta* of Heer, preoccupied by a recent species proposed by Rafinesque.

Eucalyptus angusta Velenovsky
Eucalyptus Geinitzi Heer
Eucalyptus Wardiana Berry
Ficus atavina Heer
Ficus crassipes Heer
Ficus Krausiana Heer
Ficus Stephensoni Berry
Hamamelites (?) *cordatus* Lesq.
Hedera primordialis Saporta
Pinus raritanensis Berry
Podozamites Knowltoni Berry
Proteoides lancifolius Heer
Salix flexuosa Newb.
Salix Lesquereuxii Berry
Salix pseudo-Hayei Berry
Sapindus Morrisoni Heer
Sequoia Reichenbachii (Gein.) Heer
Widdringtonites subtilis Heer

These 76 species include one thallophyte, two pteridophytes, one cycadophyte, thirteen Coniferales, five Monocotyledones, and fifty-four Dicotyledones. They are distributed among forty-nine genera in thirty-six families and twenty-six orders. The largest orders are the Pinales, Urticales, Ranales, Thymeleales, and Sapindales, each of which has six species. The largest single genus is *Ficus* with five species and the species of this genus are also the most abundant individually. The genera *Salix*, *Magnolia*, and *Andromeda* have four species each; *Araucaria*, *Celastrophyllum*, and *Eucalyptus* have three each; and the following genera are represented by two species each: *Myrica*, *Quercus*, *Proteoides*, *Leguminosites*, *Laurus*, *Laurophyllum*, *Cinnamomum*, and *Diospyros*.

The single thallophyte represented by poorly preserved remains of a dichotomously branched thallus is of little botanical interest. The pteridophytes include a species referred to *Onoclea* and a *Lycopodium*, both represented by fruiting specimens. The cycadophytes, represented by a single species referred to *Podozamites*, are an insignificant element in the flora. TheConiferales are well represented. The Taxaceae are represented by *Cephalotaxus*-like fruits which are very common in the Black Creek beds of North Carolina and also occur in the upper Tuscaloosa beds of Alabama. The other member of this family is referred to the curious fernlike genus *Protophyllocladus*, a characteristic Upper Cretaceous type widely distributed in North America. The species is new but it has been recently detected by the writer in the Magothy formation of Maryland. The family Araucariaceae, so abundant in the Mesozoic, but antipodean in the existing flora, has three typical species in the South Carolina Cretaceous: one based on foliage, another on cone scales, and the third on seeds, possibly all representative of a single botanical species. The family Brachy-

phyllaceae is represented by the characteristic and widely distributed *Brachyphyllum macrocarpum* Newberry, the last survivor of an ancient Mesozoic line. The order Pinales is represented by a species of *Pinus* of modern aspect, by the characteristic remains of the widely distributed *Sequoia Reichenbachii* (Geinitz) Heer, by *Cunninghamites elegans* (Corda) Endlicher (?), and by the widespread *Moriconia americana* Berry. The subfamily Cupresseae is certainly represented by *Widdringtonites subtilis* Heer, based upon both foliage and obscure cones, the identification of which is rendered certain by abundant attached cones from the Tuscaloosa formation in western Alabama.

The Monocotyledones are represented by five species: a *Potamogeton*, an *Arundo*, a *Phragmites*, and a *Carex*, all aquatic or strongly mesophytic types, and by the fragmentary remains of a large palmettolike fan palm which is one of the earliest representatives of this family of plants. Turning to the Dicotyledones, we find the amentiferous families represented by nine species: a *Juglans*, two characteristic species of *Myrica*, four of *Salix*, and two of *Quercus*. The Urticales are one of the most abundant orders in the South Carolina Cretaceous, easily the most abundant in point of numbers of individual specimens. A single doubtful species is referred to the modern warm-temperate genus *Momisia*. The figs number five species, four of which are lanceolate-leaved species and the other a palmately veined form. The former are exceedingly abundant at a number of localities and show a marked tendency toward the development of characteristic "dripping points," which are wanting in these forms in the northern part of their range. This peculiarity is shared by a number of other genera belonging to this flora. The family Proteaceae, in the existing flora largely and almost exclusively developed in the southern hemisphere, is represented by two species of *Proteoides*, so called from their close affinity with the modern species of *Protea*.

The order Ranales, which at the present time has received such undue prominence through the phylogenetic speculations of Wieland, Arber, and others, is represented by six species: a *Dewalquea* of remarkable and striking appearance, which occurs also in the Tuscaloosa formation of Alabama, by a new species of

Illicium, and by four well-known species of *Magnolia*, two of which range northward as far as Greenland, and three of which range southward into Alabama.

There are five species of Rosales: a *Hamamelites*, two species of *Leguminosites*, a *Caesalpinia*, and an *Acacia*-like form. The order Geraniales, while poorly represented, contains two remarkable forms: a *Citrophyllum* very close to the modern genus *Citrus*, and *Crotonophyllum*, a genus allied to the modern genus *Croton* of the family Euphorbiaceae. *Crotonophyllum* is rather common in the Middendorf beds, the only other species of the genus occurring in the Cenomanian of Bohemia.

The order Sapindales is a large one represented by six species: a form doubtfully referred to the genus *Pachistima*, a *Sapindus*, a large *Rhus*, and by three species of *Celastrophyllum*, a genus abundant from toward the close of the Lower Cretaceous until the close of the Colorado. The order Thymeleales also includes six species: two well-known species of *Laurus*, two species of *Laurophyllum*, and two of *Cinnamomum*,—one the widespread **Cinnamomum Newberryi**,* and the other new. The Myrtales have three species of *Eucalyptus*, the order Umbellales is represented by a single infrequent species of *Hedera*, and the Ericales by four species of *Andromeda*, one of which is new. The Primulales are represented by a single rather widespread species of *Myrsine*, and the Ebenales by two species of *Diospyros*.

This flora, of which a brief abstract has just been given, serves to indicate certain physical conditions which prevailed at the time it flourished. Abundantly confirmed by the character of the deposits, it indicates a considerable elevation and relief of the Piedmont area of South Carolina with numerous streams of a considerable gradient. While no precise results regarding the climate are possible, it is safe to assume that it was mild and uniform though not necessarily tropical. We may confidently assert that frosts were unknown. The climate was humid, the presence of numerous coriaceous-leaved forms being due to insolation or exposure to winds, especially along the strand, and to a swamp

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*This is a new name for the well-known species *Cinnamomum intermedium* of Newberry, the name *intermedium* having been previously used by Baron Ettingshausen.

habitat in other cases. That the rainfall was plentiful may be inferred not only from the grouping of the plants but from the development of dripping points. In a previous number of the BULLETIN, in a brief discussion of the Cretaceous flora of Georgia, the latter was compared with the modern temperate rain forest of New Zealand, for a discussion of which the reader is referred to Schimper's Plant Geography. While this resemblance of the New Zealand flora to that of the Upper Cretaceous of the Atlantic coastal plain is of a most general nature, the former offers the nearest approach among modern plant assemblages to the Upper Cretaceous flora of the Atlantic coastal plain, a fact emphasized by a consideration of this Upper Cretaceous flora as developed in South Carolina. This flora will be fully described and illustrated in a publication of the U. S. Geological Survey, now in press. The work was prosecuted under the supervision of Dr. T. Wayland Vaughan of that organization, to whom I am indebted for permission to publish the foregoing brief abstract.

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BALTIMORE, MD.

Explanation of plates 18 and 19

PLATE 18

FIG. 1. *Onoclea inquirenda* Hollick. Magothy formation, Severn River, Md.
FIG. 1a. Part of the foregoing, ×6.
FIG. 2, 3. *Gleichenia Saundersii* Berry. Magothy formation, Severn River, Md.
FIG. 3a. Pinnule of the foregoing, ×5.
FIG. 4, 5. *Asplenium cecilensis* Berry. Magothy formation, Grove Point, Md.

PLATE 19

FIG. 1. *Ilex severnensis* Berry. Magothy formation, Little Round Bay, Md.
FIG. 1a. The same, ×4.
FIG. 2. *Dalbergia severnensis* Berry. Magothy formation, Little Round Bay, Md.
FIG. 3. *Ficus matawanensis* Berry. Matawan formation, Lorillard, N. J.
FIG. 4. *Cornus cecilensis* Berry. Magothy formation, Grove Point, Md.
FIG. 5. *Diospyros vera* Berry. Raritan formation, East Washington Heights, D. C.

Rubus of eastern North America

W. H. Blanchard

In the July number of the American Botanist for 1904, beginning an article on blackberries, I wrote: "Nearly all of our botanists have avoided blackberries and are still doing so. They prefer to take up lines in which they can feel sure that everything is settled. Very little material has been collected and very little persistent, patient field work has been done. The writer has dropped the popular work that so many others are following and is making a determined, continuous, and tireless search in this neglected field." This search has continued and is now ten years old. I have searched throughout the whole of the eastern part of the United States and Canada as far west as blackberries are found, or from St. John's, Newfoundland, to Lake Winnipeg in Manitoba, and south to Florida, missing none of the states or provinces except West Virginia, South Dakota, Nebraska, Texas, Louisiana, Mississippi, and South Carolina, making the search as complete as my time and limited means would allow.

I could get little positive information from others when I got to a section, and was obliged to search out everything myself personally and generally alone. Some aid was obtained by visiting herbaria, and all such were visited if *Rubus* was known or suspected to be found, and botanists were asked for information wherever I went. The information thus gained as to stations for *Rubus* was of great value, enabling me to learn in hours what otherwise would have taken me days to have learned without it. As a result of this protracted, arduous, and expensive undertaking, I venture to say and say with confidence, that eight species include the great bulk of our blackberries, perhaps ninety per cent of them.

They occupy longitudinal belts extending across the territory under consideration, and are therefore justly distinguishable into northern and southern kinds, and not as has been suspected into eastern and western. This belting in range is broken in the case

of three species, when northern kinds follow down the Alleghany Mountains. They may be divided into three classes and with each species is given its general range.

HIGH BLACKBERRIES

RUBUS CANADENSIS L. Newfoundland to Manitoba.

RUBUS ALLEGHANIENSIS Porter. Prince Edward Island to Minnesota.

RUBUS ANDREWSIANUS Bld. Southeastern Massachusetts to Oklahoma.

DEWBERRIES

RUBUS HISPIDUS L. Prince Edward Island to Minnesota.

RUBUS PROCUMBENS Muhl. Portland, Maine, to Oklahoma.

RUBUS TRIVIALIS Michx. Southeastern Virginia to Texas.

HALF HIGHS

RUBUS RECURVANS Bld. Maine to Iowa.

RUBUS CUNEIFOLIUS Pursh. Connecticut to Texas.

RUBUS CANADENSIS L.

R. Millspaughii Britton.

The only description of this species that is sufficiently complete to be of much value is the one from my pen published in Rhodora 10: 117. 1908, and no figure of it that has yet appeared gives any clear conception of the species, though a colored illustration was given in Curtis's Botanical Magazine for July 1909. In fact no single figure can well illustrate a blackberry, unless it cover a large folio page and is drawn to a rather small scale so as to give an idea of the whole plant or a considerable part of it; and even then it needs an accompanying set of figures showing natural size. The southern limit of this species is near the northern boundary of Massachusetts, or near the 43d parallel of north latitude, though it crosses Wisconsin and Michigan at a higher latitude; and it follows down the Alleghany Mountains into North Carolina and Tennessee. It is exactly the same plant in the west as in the east. I collected twice in the same season in the northern part of the southern peninsula of Michigan, when in flower and in fruit, and

these plants and those in Vermont and New Hampshire are as near alike as those in New Hampshire are like those in Vermont. Equally typical are the sun-exposed, scattered plants on the Black Mountains in North Carolina. I visited the station from which Mr. F. E. Boynton collected the material which has been distributed from Biltmore Herbarium as *R. Millspaughii* Britton. It grows in the shade, in a rather moist place, well up on the side of Mount Pisgah, and its rank growth is not unlike that of *R. canadensis* in a moist shady place in Vermont. Though considerably beyond the flowering season, there were some fresh flowers at the spring on the top of Mt. Mitchell, the goal of mountain climbers in the South. Shaded by spruces, balsams, and yellow oaks, the resemblance to a Vermont station was nearly perfect. I did not see the grown fruit, but from specimens I have seen, some of it, at least, seems to be long and slender like that of *R. alleghaniensis* Porter, and such may be considered a weak variety which I here announce as **Rubus canadensis Millspaughii** (Britton).

RUBUS ALLEGHANIENSIS Porter

R. nigrobaccus Bailey.

Until quite recently all forms of high blackberries were included under one name, and it was supposed that their variations were not sufficiently great to make it necessary to segregate anything and no one studied them. Occasionally a collector would label a specimen that seemed different from those common in his locality *R. frondosus* Bigelow, or var. *frondosus*, and rarely some one would write on his label *R. suberectus* Hooker. For many years our high blackberries were called *R. fruticosus* L., since Linnaeus had a reference to Gronovius, who considered the bush blackberries sent him by Clayton to be the same as the European brambles, all of which Linnaeus placed in one species. Those were happy days! No germ of the coming rubiologist had appeared.

Marshall and Manasseh Cutler described the high blackberry as *R. fruticosus* in 1785, and Walter, in 1788, described it under the same name. Willdenow, in 1799, continued the reference to Gronovius in his description of *R. fruticosus* and he copied Aiton's *R. villosus* verbatim. (See under *R. procumbens*.) Michaux, in

1803, described in rather ambiguous terms *R. villosus* Ait., which as an American plant had been described in still more ambiguous terms. Michaux, or the person who wrote the description, for Michaux probably neither wrote the description nor was consulted as to it, gave as its habitat "in utraque Carolina," and incorporated into his description the queried reference "*R. hispidus?* Walt." This uncertainty was caused by Michaux's mistake in giving *R. fruticosus* Walter as a synonym for *R. trivialis* just described, and then it followed that *R. hispidus* Walter would be the same as *R. villosus* of Michaux. Michaux had transposed Walter's names.

Muhlenberg, though he had in 1791 used the name *R. fruticosus* L. for the high blackberry, yet in 1813 called it *R. villosus* Ait., evidently thus interpreting Michaux. He called it also the "blackberry." Bigelow, in 1814, perhaps following Muhlenberg as he certainly had Muhlenberg's 1813 catalogue before him, also called it *R. villosus* and described it in no uncertain language. Pursh also, in 1814, who certainly had not seen Muhlenberg's catalogue, describes *R. villosus* Ait., combining in his description the language of both Michaux and Aiton, saying it was common from New England to Carolina in old fields and commons and was known as "blackberries," while under the name of *R. trivialis* Michx. he described a plant known as "dewberries." Barton, in 1815, must have followed Michaux, though possibly because Muhlenberg had led the way, as he used part of Michaux's description of *R. villosus* including Michaux's queried reference "*R. hispidus?* Walt.," and he calls it the "high blackberry."

After the publication of the works of this quartet of botanists, 1813 to 1815, *Rubus villosus* Ait. was the settled name for all high blackberries, though Bigelow published his unrecognized *R. frondosus* in 1824. But Prof. T. C. Porter discovered in 1890 that the blackberry on the Pennsylvania hills (they call them mountains), was not the same blackberry as that on the lower Delaware. So he named it var. *montanus*, and later, in 1894, he raised it to a species, but *montanus* being a homonym, in 1896 he renamed it *Rubus alleghaniensis*. Meanwhile, in 1891, Dr. C. F. Millspaugh made a find on the mountains of West Virginia, which Dr. N. L. Britton named *Rubus Millspaughii*. So these names began to be

used. A revolution in our *Rubi* was at hand, and Prof. L. H. Bailey ascertained that *R. Millspaughii* was a common northern species named *R. canadensis* by Linnaeus in 1753; that the southern blackberry was not the same as the northern; and, to cap the climax, that *R. villosus* Ait. was a dewberry. This he announced in 1898 in his Evolution of our Native Fruits, which is the only compilation and the first exposition of the *Rubi* of our area. He has given a later view in the Cyclopaedia of American Horticulture, 1902. These articles are illustrated by many useful and some invaluable figures.

Professor Bailey, thinking *R. alleghaniensis* to be different from the common northern high blackberry, named the latter *Rubus nigrobaccus*, but he was mistaken and his name is a synonym. His idea of the other high blackberries was not entirely correct; and under the name of *Rubus argutus* Link—the original specimens of which it is impossible to place with certainty, but which are probably from an intergrade between *R. alleghaniensis* and *R. Andrewsianus*, since they have some of the distinguishing characters of each and certainly lack some of the most distinguishing ones of *R. Andrewsianus*—he lumped together *R. suberectus* Hooker and *R. frondosus* Bigelow, as well as most of the odd things of both the north and the south, giving its range as "from Lake Superior and New Brunswick to Florida, Kansas, Oklahoma and Mississippi."

Rubus alleghaniensis is not found as far north as *R. canadensis*, and near its extreme northern limits has very poor fruit, maturing but few drupelets. Some of the extreme northern stations where I have collected it are Summerside, Prince Edward Island; Frederickton, New Brunswick; Moosehead Lake, Maine; the Ottawa Valley, Canada; the northern peninsula of Michigan, and Grand Rapids, Mich. This is near the 46th parallel, and a straight line from Prince Edward Island to Lake Itaska is approximately the northern boundary of the range of this species, while its southern boundary is not far from Mason and Dixon's Line, or approximately the 40th parallel of north latitude. Some of the extreme southern points at which I have collected it are Westchester, near Philadelphia; Bloomington, Indiana; the bluffs in the northern part of St. Louis, Missouri; Wolf Creek, Tennessee; and Asheville, North Carolina. It follows down the Alleghanies at a much lower

altitude than *R. canadensis*. No satisfactory figure of this species has yet been published. The best is in the fourth volume of the Cyclopaedia of American Horticulture. The figure of *R. alleghaniensis* in Britton and Brown's Illustrated Flora is of this species, also. Bigelow figured it in his Medical Botany in 1818. No complete description of it has yet been published, but Bailey, Porter, and Bigelow have pointed out some of its characters, and some are noticed in Rhodora 8: 169, 217. 1906.

RUBUS ANDREWSIANUS Blanchard

This species was described by Marshall and by Walter as *R. fruticosus*, and by Elliott and by Barton as *R. villosus*. It has been figured in his Vegetable Materia Medica by Barton, in the Illustrated Flora under the same name, and fully described by me in Rhodora 8: 17. 1906. See also under *R. alleghaniensis* in this paper. Its northern limits are Boston, Massachusetts; Providence, Rhode Island; Granby, Connecticut, on the Massachusetts line; Easton, Pennsylvania; Mansfield, 30 miles north of Columbus, Ohio; Indianapolis, Indiana; St. Charles, Missouri; and Topeka, Kansas. I have personally collected it in those places. Its southern limit is the Atlantic Ocean and the Gulf of Mexico. Probably two thirds of Rhode Island and Connecticut, four fifths of Pennsylvania, and one third of Ohio, Indiana, and Illinois are not included in the area where this species grows. In the neighborhood of Boston this species is not normal, and in a strip bordering the Gulf of Mexico, on the evidence of specimens I have seen and from a careful examination from Pensacola, Florida, to the Alabama line, it is much more slender than this stout, rugged species usually is.

RUBUS HISPIDUS L.

This species was described for the first time by Linnaeus in 1753. Michaux named it *R. obovalis*, Bigelow named it *R. sempervirens*, and Hooker, claiming Michaux's name to be senseless, purposely renamed it *R. obovatus*. This list of Latin adjectives pretty well covers its characters. Barton called it *R. flagellaris* Willd. and he knew of a single station in the neighborhood of Philadelphia. No extended description appeared before 1906, when my own was published in Rhodora 8: 212. Its range is

nearly the same as that of *R. alleghaniensis*. I have searched carefully for it in New England and the maritime provinces of Canada, but have not given it much attention in the west and south. I have collected it near Washington in Virginia, at Asheville, North Carolina, near where Michaux collected it, and in Michigan, but I rely mostly on herbarium specimens in fixing its range west of New England. Its slender, slightly hispid form is much more common than the very hispid form, which seems to have been mistaken by some for *R. trivialis* and by others for *R. setosus*. The leaves, if not too badly exposed, remain till the next season's growth is well advanced, and flowering specimens should, if possible, be secured on which some of the leaves remain. Helpful figures are given by both Bailey and Britton.

RUBUS PROCUMBENS Muhlenberg

This is given in Gray's New Manual as *Rubus villosus* Ait. on the opinion of Professor Bailey, who thinks the specimens from which *R. villosus* was described, and which he saw in London, are the same as "our northern dewberry," which, by the way, is as much southern as northern. However, Bailey says it occurs in the south as far as "Florida, Kansas, Oklahoma and Arizona." *R. villosus* was described in Hortus Kewensis, which was a descriptive catalogue of all the plants growing in the Kew Botanic Garden, of which Wm. Aiton was the head. The descriptions were not the work of Aiton, who seems to have been a gardener rather than a botanist and deposited dried specimens in the herbarium of Sir Joseph Banks, but were written in the herbarium by Solander. So Hortus Kewensis is the work of Aiton in the same sense that Michaux's Flora Bor.-Am. is the work of Michaux. The description is so short and poor that nothing can be made of it. This accounts for its so easily deceiving the author of Michaux's Flora and the American botanists. The meaning of the name alone caused them to use it.

It is by no means certain that *R. villosus* is the same as *R. procumbens*. The illustration Bailey has given of the original specimens shows a very different plant from the typical *R. procumbens*.

The name *R. procumbens* was first given in Muhlenberg's Catalogue, but Barton, in 1818, in his Compendium Florae

Philadelphicae, gave a description that answers all requirements of later rules for properly describing a species. Linnaeus included it in *R. caesius* by a reference to Gronovius who thought Clayton's specimens and description (1743) indicated that it was the same as the European dewberry. Marshall, in 1785, described it as *R. hispidus* L., Bigelow described it in 1814 as *R. trivialis* Michx., and so did Torrey in 1834; but when Dr. A. Gray took hold with Torrey they concluded to call it *R. canadensis* L. The name had been in the books for many years. Kalm collected it in Canada. Torrey had used the name in 1824 for the *Rubus* they were about to call *R. triflorus* Rich. (now *R. pubescens* Raf.). This dewberry was evidently not *R. trivialis* Michx. as Torrey had supposed. Here was a *Rubus* that might be the long lost *R. canadensis*. It is nevertheless surprising that Gray should have used this name, since he had seen the original specimens, and in a note to the description in their Flora of North America shows how Linnaeus had unwittingly described it as having ten, five, and three leaflets. Having made this correction he seemed to think that *R. canadensis* had been cleared up and was the dewberry under consideration, when, in fact, the specimen did not have the slightest resemblance to it, but was typical *R. canadensis* as we know it. I have seen a photograph of it, which Professor Bailey secured but unfortunately has not used in his books. They passed by the good name given it by Barton and by Muhlenberg. It is more than probable that Gray had forgotten how the original specimen looked. He had seen Aiton's specimen of *R. villosus* too.

So the name Torrey and Gray used held undisputed sway till Bailey explained the mistake and applied the name *R. villosus*. But Dr. P. A. Rydberg, in Britton's New Manual, in 1901, restored the name Muhlenberg gave it. The only full description is that by the writer in Rhodora **8**: 147. 1906. No good figure of it has ever appeared; in fact there are only those given by Bailey and the one in the Illustrated Flora.

Its range covers more square miles than any other blackberry in eastern North America. It ranges from the Gulf of Mexico to the southern limit of *R. canadensis* L. To be more specific, its eastern limit is the Kennebec River in Maine, and a line due west from Portland, Maine, or about the 44th parallel, is near

the northern boundary of its range. It undoubtedly occurs in every state east of the Rocky Mountains, with possibly the exception of North Dakota. It is not everywhere equally abundant. In the northern parts of Ohio and Indiana it is scarce, though abundant on the shore of Lake Michigan. It is the same plant wherever found, the same in Boston as in Pensacola, New York as in Oklahoma, Michigan as in Georgia.

RUBUS TRIVIALIS Michaux

Walter, in 1788, apparently described this species as *R. hispidus;* Michaux's name and description appeared in 1803; Elliott, in 1822, also used the name *R. trivialis*, and his description is perhaps the best that has yet appeared. Its range is from southeastern Virginia to Oklahoma and Texas, and forms of it occur in the mountains of New Mexico and Arizona. It is especially abundant in the sandy pine region near the coast, its northern limit being a curved line extending from Norfolk, Virginia, through Raleigh, North Carolina, Columbia, South Carolina, Milledgeville, Georgia; to Fort Smith, Arkansas, and Muscogee and Oklahoma City, Oklahoma. I collected it in the last three places named. It and *R. procumbens* are about equally abundant at Montgomery, Tuskegee, and Opelika, Alabama, but in western Florida *R. trivialis* greatly preponderates. Michaux gave its range as Carolina and Pennsylvania, and this caused botanists to think he included *R. procumbens* in his species. Many have confounded it with *R. hispidus* also. It was figured by Guimpel in 1825, and one of the two original specimens collected by Michaux is shown in the Cyclopaedia of American Horticulture (1902).

RUBUS RECURVANS Blanchard

This species was described by me in Rhodora **6**: 223. 1904. It had never been recognized as a species though it is very distinct. This is not surprising since several other good species were not recognized till recently. When it was abundant people often called it the "half-high" blackberry as they call *Vaccinium vacillans* the half-high blueberry. When Bailey published *R. villosus* var. *Randii* some botanists used that name for it, but Bailey seems to have considered it to be a blackberry-dewberry

hybrid. His two illustrations on pages 315 and 317 in Evolution of our Native Fruits, also reproduced in the Cyclopaedia of American Horticulture, are probably of this species. They give but a poor idea of the species, however. The halftone is poorly made from a poor specimen, and the etching is intended to show only the fruit. The characters of this species, in fact, are as good and as constant as those of any other; it is exactly the same in Michigan as in Massachusetts; and it is found at least one hundred miles from any station of the dewberry. Its range is from western Maine to Iowa. It is common or frequent throughout most of New England west of the Kennebec River, and I have collected it in Ottawa, Canada; Plattsburg, Oswego, and Rochester, New York; in many places in and around Ann Arbor and Lansing, Michigan; and at Mason City and Ames, Iowa.

RUBUS CUNEIFOLIUS Pursh

This species was first described by Walter, in his Flora Caroliniana, in 1788, as *R. parvifolius*, but his name had already been used and it takes Pursh's more descriptive name, which he gave it in 1814. The description of it given by Pursh was improved on by Elliott in 1822. Its range is from the Connecticut River in Connecticut to the Mississippi River and perhaps beyond. In going south from Louisville, Kentucky, I found it first at Decatur, Alabama. In Florida it seemed to be the common "briar." In some places it seems to intergrade with *R. Andrewsianus*. Suggestive figures are given by Bailey in connection with his writings on *Rubus*.

In addition to these there are some others with a range great enough to be of interest to botanists generally. An important one is

RUBUS FRONDOSUS Bigelow

This species, which I resurrected from seeming oblivion in 1906, is found from Boston to Washington, in a strip bounded by the ocean on one side and a line marked by the following stations on the other side: Clinton, Mass.; Hartford, Conn.; Lancaster, Pa.; and Fairfax, Va. Bigelow described it in 1824. The announcement of the refinding of this lost species and a short

description are in Rhodora 8: 217. 1906. The southern form, which is somewhat different from the northern, I described in Torreya 7: 55. 1907 as *R. philadelphicus*. I am by no means certain this separation should be given up. *R. frondosus* is abundant in and all around Boston. I collected it also in many other places in central and southeastern Massachusetts, and found it abundant in the vicinity of Providence, Rhode Island. It is scattered over much of Connecticut, is abundant in all directions around Philadelphia, and occurs about Lancaster, Pennsylvania. About Washington as far as Fairfax, Virginia, it was plentiful. Specimens of *R. canadensis* L., especially flowering ones, are found in northern herbaria labeled var. *frondosus*, for Torrey and after him Gray never recognized it as more than a variety of *R. villosus*. The total misconception Gray had of it is shown by the query "Is this *frondosus*?" on a sheet in the Columbia University Herbarium of a leafy-bracted raceme of *R. alleghaniensis;* that is, it is a long, normal raceme except that nearly all of the pedicels are subtended by unifoliate leaves, a form not rare if one is watching for the unusual forms. Beck and Eaton both accepted it as a species, as they made a rule to omit nothing ever proposed.

Then there is an interesting class of blackberries found chiefly and possibly only east of the meridian of Philadelphia, from eastern New York to or nearly to the Gulf of St. Lawrence, of which no mention was made before 1824, when Bigelow published

RUBUS SETOSUS Bigelow

Torrey and Gray accepted this so far as to make it a variety of *R. hispidus* on the strength of two specimens sent by Bigelow, and Beck and Eaton accepted it as a species of course. Since *Rubus* has been examined more carefully, within the last twenty years, the name *R. setosus* has been used as a blanket name for this whole class; but there is such a diversity of forms that the name does not convey a very definite idea. It has been proposed to divide it up sufficiently to make it possible to know by name the principal forms. In the New York State Herbarium at Albany there was (and is) a specimen of *R. hispidus*, not particularly unusual, which Torrey had marked as var. *setosus;* so, when

in 1891 Prof. C. H. Peck found at the base of the Adirondacks a peculiar setose, erect or partly erect blackberry, he gave it a new name, *R. hispidus* var. *suberectus*. In 1901, in Britton's New Manual, Rydberg raised this to specific rank since it differed a good deal from Bigelow's two specimens of *R. setosus*. He could not use Peck's varietal name as it would be a homonym, so he published it as *R. nigricans*, Peck's dewberry. This was the first segregation. This plant is the erect or nearly erect, often erect, 5-foliolate, soft-stemmed, densely soft-bristled form, having abundant glandular hairs, the common form in moist situations at low altitudes, and often in dry places at higher altitudes—the common form in Vermont and New Hampshire. In Connecticut it is found in low places. The type specimen is figured in Bailey's Evolution of Our Native Fruits and in the Illustrated Flora. Another segregate is *R. semisetosus*, published by me in Rhodora **9**: 8. 1907. This prefers dry land, has terete, hard stems, is seldom quite erect, and has retrorse, bristle-pointed prickles; it is especially abundant in Connecticut on the sand plains. Still another segregate appears in Rhodora **8**: 213. 1906 as *R. hispidus* var. *major*. Some forms of *R. hispidus* are so coarse, so different from the most hispid forms that appeal to one as *R. hispidus*, that a name and a place for them seems desirable.

There is yet another plant having a slight suggestion of this group and very abundant in Vermont, especially in the higher parts, which I named and described in the American Botanist for July 1904, p. 1, as *Rubus vermontanus*. This was mistakenly assumed by the authors of Gray's New Manual to be *R. nigricans* Rydb. There is still left a large amount of this *setosus* aggregate to which to apply the name *R. setosus* after these segregations have been made, especially of the decumbent, soft-bristly, trifoliolate forms.

In Maine and the maritime provinces of Canada there are four species that have a wide range, all of which were described by me in Rhodora in 1906. *Rubus amabilis*, since renamed *Rubus amicalis*, ranges from southwestern Maine to the Gulf of St. Lawrence. While I have not yet found any new stations in Maine, I have collected it in many places in southern New Brunswick and in Nova Scotia, where it is especially abundant in the

Annapolis Valley. It is very constant in form, and I have seen no tendency to vary, which, in an abundant blackberry is very unusual.

Rubus glandicaulis, also very distinct, has a wide range. It is frequent throughout southern Maine as far north as Brownville and Bangor, and in southwestern New Brunswick to Fredericton Junction, and occurs in Nova Scotia. This, or forms close to it, I have collected on Lake Winnepesaukee, New Hampshire, and at Lenoxville, Province of Quebec.

Rubus multiformis is a species that is somewhat variable, and occurs from southwestern Maine to Sydney, Cape Breton Island. Throughout this long stretch it is the only trailing blackberry that you often see except *R. hispidus*. Its shining green 5-foliolate leaves, the leaflets long and very narrow, are very noticeable.

Rubus recurvicaulis ranges from Marblehead, Massachusetts, to Bar Harbor, Maine. On Mt. Desert Island it is very abundant and I collected what is probably this species near Halifax, Nova Scotia. Prof. M. L. Fernald regards this as the true *Rubus Randii* (Bailey) Rydb. in Gray's New Manual. It is impossible to tell, as the original specimens are manifestly aberrant no matter what they are. Nothing matches them and all sorts of odd things have been thrown into *R. Randii* covers. But *R. recurvicaulis* is a very distinct species. I have visited Mr. Rand's stations, using a large scale map on which he marked them and with directions orally and carefully given me, but I found nothing at one station and something very different, but odd, at the other. Unless Mr. Rand himself rediscovers his stations and gets better material, his species cannot be maintained. No *R. recurvicaulis* was found in the neighborhood of his stations though I took much pains to examine. My chief object in spending so much time there (over a week) was to clear up *R. Randii* if possible.

There are undoubtedly many local species of blackberries in our area. Most of them will never be described, or if they are will soon be forgotten. There is a practical as well as scientific side to systematic botany. The world will not bother with an interminable number of species in a genus. The way that Gandoger is ignored and Rafinesque was ridiculed shows it. The number of species in *Aster*, *Crataegus*, *Rosa*, *Rubus*, etc., must have

some limit. Some day a second, perhaps greater Linnaeus, a species and genus smasher will appear who will be idolized in the future as Linnaeus is [?] today.

Of the various species of *Rubus* I have described, according to what has already become known, some will be found to be only local, some will have a limited range, and some as I have already found will have a wide range. Whether the blackberries in our area have been evoluted, mutated, or hybridized from one, two, or ten original species is a matter of pure speculation, though interesting and profitable no doubt, but that names are needed for a reasonable number of the common forms is a fact so patent that argument is unnecessary. The attempt to use formulas of pedigree for plant names reminds one of the pre-Linnaean nomenclature. Such a formula as *R. alleghaniensis* ¼ × *R. procumbens* ¼ × *R. Andrewsianus* ½, which is one of the simplest, for the name of a common and constant plant is not likely to appeal to most people, though it might be very useful in describing a plant. It is also useful in marking odd specimens in the herbarium, and may well be introduced into floras to a limited extent.

My observations lead me to think that Mr. E. P. Bicknell's *R. Baileyanus* is a shade form of *R. procumbens*, that his *R. Enslenii* is a common sand form of the same species, and, if these two assumed species were transplanted so as to grow under such conditions as typical *R. procumbens* usually has, they would in time return to a form unmistakably that of *R. procumbens*. It is to be hoped he will thus transplant them. If *R. flagellaris* Willd. is an American plant it probably is a form of *R. hispidus*. The figure to which Mr. Bicknell refers does not indicate any remarkable variation from *R. hispidus*. I have never seen a constant intergrade between *R. hispidus* and *R. procumbens*, but I have seen many that were not constant.

I have not seen all of Mr. Ashe's *Rubi* but his *R. Boyntoni* is a good local species, very frequent in much of Buncombe County, North Carolina, as I know from observation. *R. floridus* Tratt. may be a local species, but it cannot have a great range, unless, as I suspect, it is a name given to the terete ends of a form of *R. Andrewsianus* not rare around Philadelphia and Washington. This form has recurving branches which are armed with recurved

prickles, and specimens from different parts of such a plant might easily be mistaken for two species.

On the evidence of some very divergent forms of *R. trivialis* which I saw in Alabama, and from specimens I have seen, some very interesting developments may be expected in Texas, Louisiana, and Mississippi. *R. trivialis* seems to grade into some coarse forms, some of which have a very different form of inflorescence. Robin, in his Flore Louisianaise, described two *Rubi* which, he wrote, were abundant in Louisiana, and Rafinesque gave them names. His *R. nitidus* is undoubtedly *R. trivialis*, and his *R. angulatus* ought to be recognized.

WESTMINSTER, VT.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1909–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Börgesen, F. Some *Chlorophyceae* from the Danish West Indies. Bot. Tidssk. **31**: 127–152. *f. 1–13.* 1911.

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Brandegee, T. S. Plantae Mexicanae Purpusianae, III. Univ. Calif. Publ. Bot. **4**: 177–194. 1 Jl 1911.

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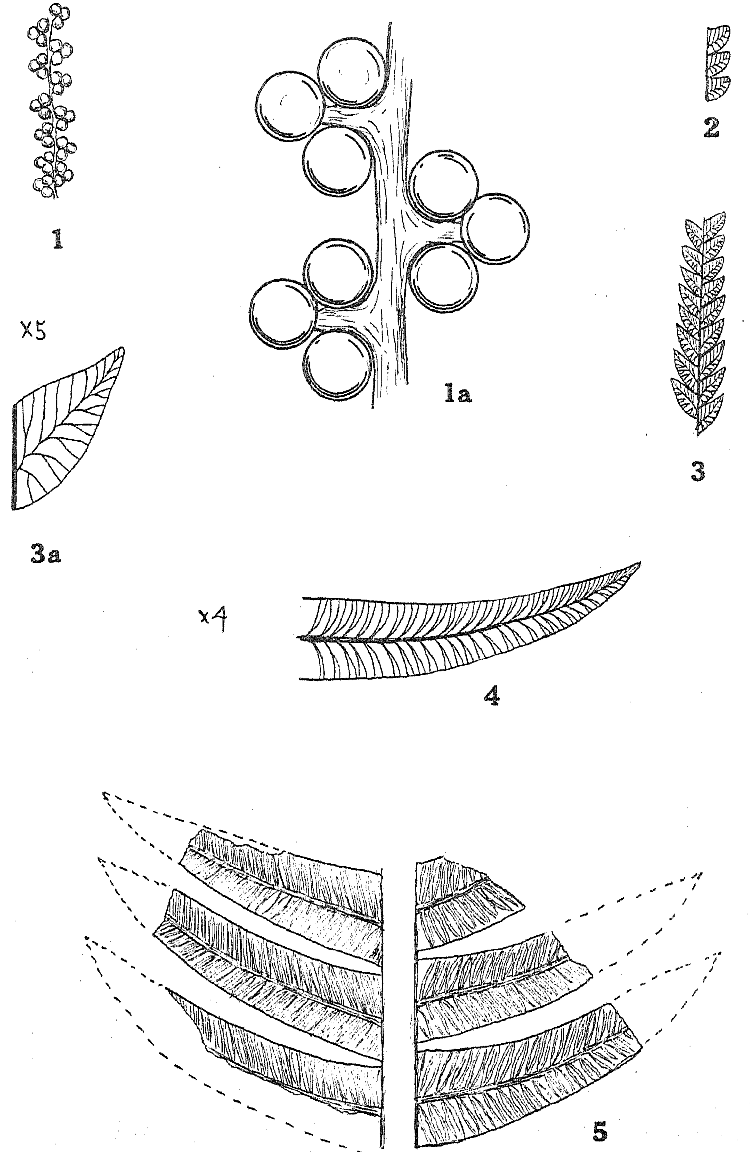
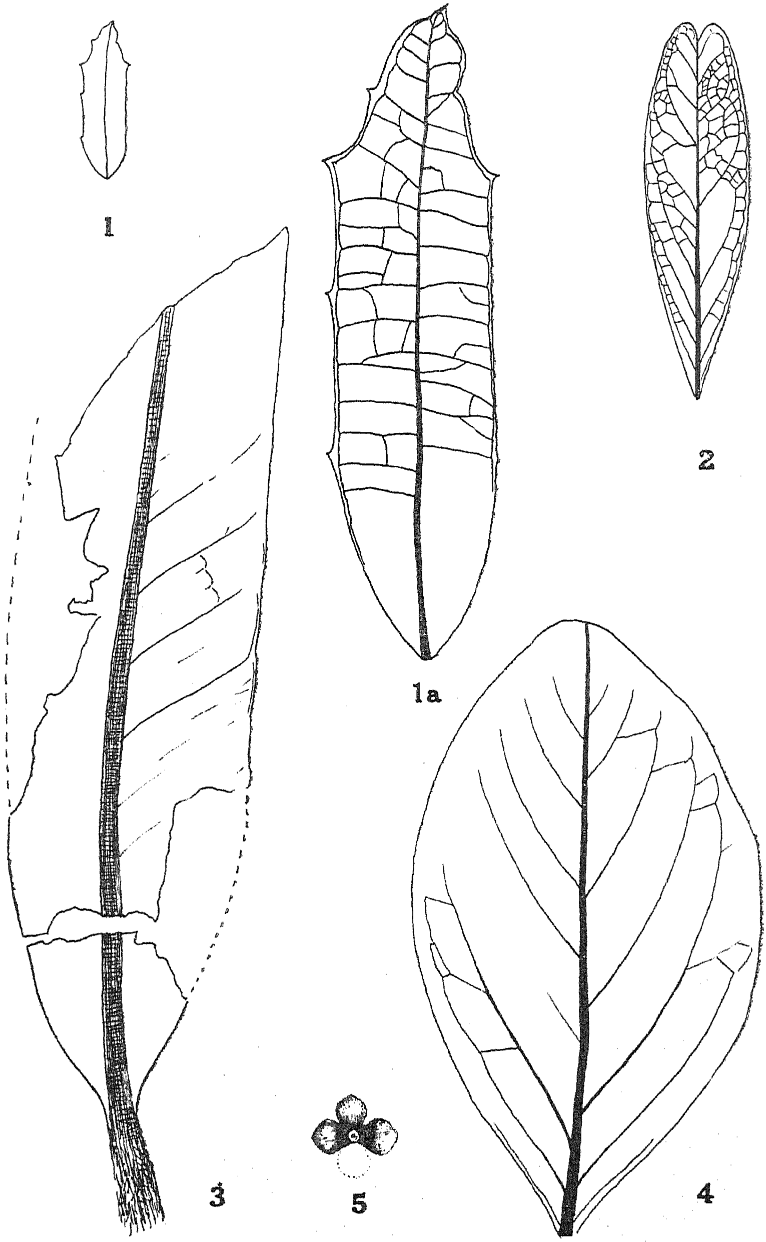


UPPER CRETACEOUS FILICALES



UPPER CRETACEOUS DICOTYLEDONES

Vol. 38 No. 10

BULLETIN

OF THE

TORREY BOTANICAL CLUB

OCTOBER, 1911

The ferns and flowering plants of Nantucket—VIII

EUGENE P. BICKNELL

ROSACEAE (continued)

SPIRAEA LATIFOLIA (Ait.) Borkh.

Uncommon; a few small plants between Siasconset and Saul's Hills (1899) and west of Sankaty (1906); a considerable growth at Rotten Pumpkin Pond, in full flower, Aug. 11, 1906.

SPIRAEA TOMENTOSA L.

Scarce, but widely scattered; often undersized. Below the "Cliff"; Maxcy's Pond; the Woods; Polpis; Quaise.

FRAGARIA VIRGINIANA Duchesne.

Common in fields, thickets, and grassy places generally, sometimes in pure sand. First ripe fruit June 10, 1911, but some plants still in blossom June 15.

FRAGARIA VESCA L.

Well established in the thorn lot, growing with *Fragaria virginiana* in the grass along the fences. Green fruit and some remaining flowers June 19, 1910. Rather a small form of the species, the fruit hemispheric to subglobose.

ARGENTINA ANSERINA (L.) Rydb.

Found at one spot only, on the western side of the island near the south shore, close to a small pond lying between Hummock Pond and the life-saving station. Here, on June 7, 1910, a shallow grassy depression in the sandy plain, some seven by eight paces in extent, was starred with its earliest flowers. Flowers commonly smaller than those of *Argentina litoralis*, spreading 2–2.8 cm.,

[The BULLETIN for September 1911 (38: 399–446. *pl. 18, 19*) was issued 6 O 1911.]

in color more of a lemon yellow, the petals not emarginate; larger leaves 2.5 dm. long with leaflets over 5 cm.; young leaves silvery sericeous on the upper surface, becoming bright light green and glabrate; roots simpler, stouter, and more woody than in *A. litoralis*, often subtuberous thickened.

*ARGENTINA LITORALIS Rydb.

Local about the borders of salt marshes along the harbor from Quaise to Polpis, also by Sachacha Pond; common in a brackish or nearly fresh meadow at Shawkemo; not found on the south shore. In full flower June 2, 1909, June 7, 1908, June 20, 1910; some plants still in bloom Aug. 5, 1906. Flowers variable in size, the largest having a spread of 3–3.5 cm.; petals deeper yellow than those of the preceding species, emarginate; leaves bright green and glabrous on the upper surface. Occasionally in moist places where the soil has been enriched by deposits of eelgrass, the plant takes on an unusually strong growth, the leaves becoming over 3 dm. long, with leaflets over 5 cm.; in harder or drier soils it is often notably reduced in size.

POTENTILLA ARGENTEA L.

Common in sandy fields, especially in the town region, but extending across the island from Madequet to Quidnet. Just in flower May 31, 1909, June 3, 1911, June 15, 1910; late flowers at one locality Sept. 19, 1909.

POTENTILLA MONSPELIENSIS L.

Not common, but occurring in nearly all quarters of the island, usually, however, solitary plants or only a few together. Found in waste spots and near cultivated land, as well as in low grounds at remoter places, as at Pout Pond, Wigwam Pond, and Pocomo Head Pond. Not yet in flower June 7, 1909; freshly in bloom June 18, 1909; a single plant bearing flowers Sept. 21, 1907.

POTENTILLA CANADENSIS L.

Common in fields and thickets. Freshly in flower May 30, 1909, June 3, 1911.

POTENTILLA SIMPLEX Michx.

Frequent in damp thickets and low grounds; first flowers June 2, 1909, June 7, 1908.

*POTENTILLA PUMILA Poir.

Common in dry open places in poor or sandy soil. Among the Miacomet pines, where the trees grow thickly and the soil remains damp beneath their protecting shade, there grows a form of this species, I do not determine it to be any other, which departs widely in appearance from the typical plant. It is marked by very delicate structure throughout, slenderly filiform and flexuous stems and pedicels, and rather large bright green leaves, the thinly pubescent leaflets becoming broadly cuneate-obovate and saliently dentate or incised mostly above the middle. With it occurs a form of *Potentilla canadensis* somewhat similarly modified but in less notable degree.

GEUM CANADENSE Jacq.

Rather common in thickets on the eastern side of the island from Shawkemo to Squam. A few plants remaining in flower by the middle of August, 1906; a single belated blossom Sept. 17, 1907. No flower buds visible up to June 26, 1910.

Note.—It appears that through an error now impossible to account for, the name *Geum virginianum* L. somehow found its way into Mrs. Owen's catalogue. Mr. F. G. Floyd has recently written to Mrs. Owen in regard to the status of this species as a Nantucket plant and has kindly sent me her reply, in which she entirely repudiates that entry in her list and expresses the wish that it be corrected. Mrs. Owen writes that she has consulted the original notes and records on which her catalogue was based, which contain no reference whatever to the plant in question, "which she never found herself or had reported by any body else from Nantucket."

AGRIMONIA GRYPOSEPALA Wallr.

A. hirsuta (Muhl.) Bicknell.

Frequent in thickets throughout the same section of the island occupied by *Geum canadense*, and often growing with it.

Conformity with the practise of the day leads me to use for this species the name given by Wallroth, an appropriate name indeed, but nevertheless one junior by some thirty years to that bestowed by Muhlenberg, whose good botanical eye first saw a distinctively American plant in our species hitherto viewed as a plant of Europe. The priority of Muhlenberg, however rejected

by the rulings of the day and hour, may not, perhaps, for all botanical time be held in disregard. For it is not impossible to conceive that the course of nomenclatural reform in its ebb and flow may some day finally swing true to the line of organic morals, receiving for this plant, as for many another, the distinctive name by which it was first baptized into the annals of botany. In an early chapter of Genesis we find a primary if not now controlling law of nomenclature first laid down.

*__Agrimonia Bicknellii__ (Kearney) Rydb. comb. nov.

A. mollis var. *Bicknellii* Kearney.

Infrequent or rare; a few plants at the border of a thicket in Squam and at two stations in Quaise (1906), in full flower Aug. 13; Watt's Run bank June 15, 1908, a few plants not yet in bud.

ROSA CAROLINA L.

Common in swamps and low grounds.

ROSA VIRGINIANA Mill.

Abundant either in dry or moist soils, often massed in extensive growths and forming an entanglement of formidable character about the borders of low thickets and on banks passing down to pond holes or low grounds. First flowers June 17, 1908, June 17, 1910; not yet generally in flower June 23; a few flowers remaining Sept. 10, 1907.

*ROSA sp.?

I do not venture here to add a new name in a group of roses having already a too perplexed synonymy, and yet I would give express recognition to a rose closely allied to *Rosa virginiana*, which nevertheless seems to announce itself with some emphasis as being not the same. It is primarily distinguished by pyriform fruit, narrowed towards the base or decursive on the peduncle. In typical *Rosa virginiana* the broadly depressed globose fruit, expanded abruptly from the peduncle, contrasts notably with that of this Nantucket and Long Island rose, which is found growing with it, less often intermixed than in separate associated colonies. It remains to be determined whether forms appearing intermediate between the two represent natural transitions from one to the other or are a result of hybridization. It has not appeared that the marked differences in the fruit are attributable to the presence of a fungus or to insect agency.

As compared with *Rosa virginiana* typical examples of this associated rose differ in their more slender, straighter, and longer infrastipular spines and less numerous prickles; numerous often crowded leaves, smaller and narrower more membranous stipules and leaflets, the latter more narrowed to the base and finely serrate with very acute teeth, dark green and shining above, pale or lighter green beneath; flowers fewer and less clustered, commonly 1–3, not large, spreading about 5 cm., the petals deeply emarginate; fruit lighter red, more or less pyriform, or tapering into the peduncle, contracted or narrowed to a smaller orifice and with thicker walls; calyx lobes densely glandular, often much elongated, narrow, in fruit often widely ascending or suberect, commonly lobed much as in *Rosa humilis*.

*ROSA CINNAMOMEA L.

Several scattered plants along an old field south of the town, June 12, 1908, just in flower.

ROSA RUBIGINOSA L.

First observed in 1904, a clump over five feet high in an old field north of the town, where it must have been established for many years; fence corner west of the town; two clusters in a field southwest of Millbrook Swamp (1908); a single bush on the county fair grounds (1909).

*ROSA RUGOSA Thunb.

Straying energetically from cultivation and sometimes appearing far from planted grounds. A single plant by the roadside north of the town, first observed in September 1899, had become a conspicuous growth in 1904. Up to that time this rose had not been noticed elsewhere outside of cultivation except in a neglected lot above the "Cliff," where it had long been established and where it has spread extensively in recent years. In 1908 it had sprung up in several places by fence borders in the neighborhood of the town and was observed on the bluff at Siasconset. The following year single clusters were found at Shawkemo and at as remote and desolate a spot as among the sand dunes in the southwestern extremity of the island. An even more remote station was the sandy shore of Tuckernuck, where a fine cluster in full flower was observed on June 17, 1911. In 1910 an isolated patch flowered in a meadow below the "Cliff." First flowers June 1, 1909, June 3, 1911.

The tenacity with which this rose keeps its foothold when once rooted is well shown by a vigorous cluster, which was found in 1907 flowering on the exposed ocean front on the south shore of the island, at the site of the old Surfside hotel. The hotel, I am told, was demolished in 1901 and had been abandoned some years earlier, and this rose remained the sole vestige of the planting that had brightened the wind-swept and barren spot nearly a decade before.

*PYRUS COMMUNIS L.

Occasionally met with in a wild state, sometimes in far out of the way places. Small trees are frequent in pine scrub south and southeast of the town. A single tree, about seven feet high, grows in a wild thicket towards Quidnet, and a small tree similarly isolated was found in Squam. The only wild tree met with, bearing fruit, grows among scattered pines on the commons, perhaps two miles east of the town; on June 14, 1911, it was about nine feet in height and measured eighteen inches around, six inches above the base.

*MALUS MALUS (L.) Britton.

Frequent among the pines along the old south road, where, I was told, it produces an abundance of small fruit; occasional by roadsides and in old fields, often in a dwarfed or straggling condition; Squam; Surfside road; on the bluff at Siasconset; a tree about fifteen feet high in woodland at Beechwood. Still in blossom June 1, 1909.

ARONIA ARBUTIFOLIA (L.) Medic.

Common in low thickets and pond borders as well as in perfectly dry soils, even in pine woodland. Just in bloom May 30, 1909; everywhere in conspicuous blossom June 17, 1911.

*ARONIA ATROPURPUREA Britton.

Common in dry open places as well as in low grounds. Often untypical, indicating an involved relationship with the preceding. First flowers May 30, 1909; some blossoms remaining June 15, 1910.

*ARONIA NIGRA (Willd.) Britton.

Infrequent, boggy spots near Gibbs Pond; Wigwam Pond; west of Sachacha Pond; near Long Pond; Quaise; Siasconset; a solitary

cluster, perfectly typical, in a dry pine grove on the Surfside road. First flowers May 30, 1909. Petals sometimes rose color in drying.

AMELANCHIER CANADENSIS (L.) Medic.

Thickets and banks, mainly on the eastern side of the island; pine barrens east of Hummock Pond, some flowers as late as June 12, 1909. The largest examples, found at Beechwood and in Quaise, were 15–20 inches in circumference and were estimated to be twenty to twenty-five feet in height, their leaves becoming as large as 11 cm. long by 6 cm. wide, many of them deeply cordate. One of the stoutest examples of the species I have ever seen was met with on Tuckernuck, June 17, 1911; although not more than twenty feet tall it measured forty-two inches around near the base, and thirty inches around above the first fork of the trunk.

It was unexpected to find thriving on Nantucket a tree having elsewhere so strong a bent for wooded hillsides and rocky surroundings. Here the absence of such conditions has forced it occasionally into low thickets in association with *Amelanchier oblongifolia;* and, growing with the typical forms, there occur others difficult to assign as between one and the other of these Juneberries. With two so closely related species placed in association, intercrossing might well be expected, and these intermediate forms are perhaps thus to be explained.

*AMELANCHIER OBLONGIFOLIA (T. & G.) Roem.

Common in low thickets. Full racemes of flowers as late as June 3, 1909; other individuals out of bloom and bearing green fruit by May 30. Petals 8–14 mm. long by 2.5–4 mm. wide. The largest tree observed was in a wet thicket in Pocomo and measured twenty-three inches in circumference about a foot above the base.

***Amelanchier nantucketense** sp. nov.

An erect, at length compactly much branched and very leafy shrub 1.5 dm. to 2 m. high, the bark of the younger parts purplish brown becoming dark gray; leaves often crowded, firm, thickened at maturity, dark bluish green on the upper surface with a subglaucous bloom, at length shining, pale beneath, especially at full maturity, those of the woody branches commonly small, often only 2–3 cm. long and 1.5–2 cm. wide, oval or elliptic and abruptly rounded at each end, or broadened above and more or less cuneate

at the base, finely and acutely serrulate or serrate, especially above, often entire towards the base, in vernation densely rufescent or white-tomentulose, especially on the lower surface, early becoming glabrous beneath but long retaining scattered hairs on the upper face; petioles mostly 1–1.5 cm. long, soon glabrous; leaves of the shoots and young branches becoming 5 cm. or more long and broad, many cuneate-obovate and coarsely dentate-serrate, the primary veins with rather broad interspaces; racemes numerous, short, erect, terminating short leafy branchlets 2–5 cm. long, which are erectly disposed along short or elongated erect or ascending branches, the axis and pedicels early glabrous; flowers 6–14, crowded in small spikelike racemes; pedicels firm, somewhat clavate, mostly 1–1.5 cm. long; calyx lobes rather narrow, lanceolate, acute or attenuate, early reflexed; petals very small, narrowly linear or spatulate, frequently involute, 3–4 mm. long, 1 mm. wide distally; fruit small, globose, reddish purple, slightly glaucous, the surface of the ovary glabrous.

Common on Nantucket in low grounds about the borders of swamps, as well as on the dry moorland and in pine barrens. Passing out of bloom towards the end of May, belated flowers sometimes remaining into the second week of June. Young fruit also at the end of May, becoming mature a month later.

Type near Reed Pond, May 30, 1909, in flower and young fruit; young fruit and leaves of young branch June 10, 1908, in the herbarium of the N. Y. Botanical Garden.

Almost the first one of the not readily determinable plants of Nantucket which drew my attention on my earlier visits to the island is the Juneberry here described. This shrub has since been referred by Dr. B. L. Robinson, on the basis of specimens collected on Nantucket by Judge J. R. Churchill, in 1904, to his new var. *micropetala* of *Amelanchier oblongifolia*, the type of which was from "ledges towards the summit of Blue Hill, Milton, Mass." (Rhodora 10: 33. 12 Mr 1908.) I have not been able to convince myself that the low and small-flowered Juneberry which finds its home on ledges and exposed rocky places is the same as the seemingly very local and coastwise Nantucket shrub. The rock-loving species is the plant described by Dr. N. L. Britton under the name *Amelanchier spicata* (Lam.) Dec. It is common along the crest of the Palisades of the Hudson River, growing on the most exposed ledges, and is found also rooted in the crevices of rocks

on Manhattan Island as well as in similar situations in Connecticut, New Jersey, and Pennsylvania. A number of years ago this plant was made the subject of careful study by Doctor Britton and myself and we could then reach no other conclusion than that it was an unrecognized species. Subsequently Doctor Britton consulted, at Paris, the type of Lamarck's plant and was satisfied that it established the identity of our saxicolous species.

A character of this plant (*A. spicata*), although not of primary import, nevertheless having a suggestive value, is the white woolly exposed surface of the ovary. By this the plant would seem to be allied to *Amelanchier rotundifolia* (Michx.) Roem. [*A. sanguinea* (Pursh) Lindl.], and additional evidence of such relationship is seen in the form taken occasionally by the leaves and in the pronounced close venation which they sometimes develop. *Amelanchier nantucketense*, on the other hand, is undoubtedly in closer relationship with *Amelanchier oblongifolia* and, like that species, has the top of the ovary nearly or quite glabrous. Both are to be found growing together on Nantucket, displaying contrasts of leaf and flower which I do not think have been given undue recognition in the disposition here made of the new plant. A Juneberry collected in a bog at Long Pond, Aug. 12, 1906, growing with this species and with *A. oblongifolia*, appears to be intermediate between them and is quite probably a hybrid.

CRATAEGUS

It appears that, instead of a single species of white thorn, which it has been supposed was the sole representative of its group native on Nantucket, four or quite possibly five native species belong to the island's flora. One of these, *Crataegus pruinosa* (Wendl.) C. Koch, grows also on Tuckernuck Island and on Chappaquiddick Island, Marthas Vineyard; another, *Crataegus chrysocarpa* Ashe, of which only a single shrub was met with on Nantucket, is on Marthas Vineyard rather frequent; still another, *Crataegus Bicknellii* Eggleston, frequent on Nantucket, is not known to occur anywhere else. The comparison is interesting, that of four species collected on Marthas Vineyard two have not been found on Nantucket, one of which, *Crataegus schizophylla* Eggleston, is, so far as we now know, endemic on Marthas Vineyard, paralleling

the case of *Crataegus Bicknellii* of the more eastward island. It should be said that these two endemic thorns are not at all closely related, belonging, indeed, to very different sections of their group.

For the determinations of all the species I am indebted to Mr. W. W. Eggleston, who has kindly examined my entire series of *Crataegus* specimens collected prior to the present year, and supplied the names here employed.

CRATAEGUS CRUS-GALLI L.

Mrs. Owen, in her catalogue, speaking of the cockspur thorn, says "a hedge enclosing a tract of land west of the town, set out by William Henry Gardner about 1830", and adds "no wild plant has yet [1888] been reported on the island." A decade later the status of this thorn on Nantucket had undergone considerable change. It was found in 1899 that low bushes and small trees had established themselves here and there by roadsides and in old fields and thickets, west and southwest of the town, extending as far as Hummock Pond and the western edge of Trot's swamp. The species is, however, spreading very slowly, and more recent years have witnessed little increase in its numbers. The largest of these wild trees grows at the border of Millbrook Swamp and in 1904 was estimated to be over ten feet in height. There is also a colony of trees in the town, at the foot of the "Cliff," and an old tree surrounded by a numerous scattered progeny among the pines on the site of the old O'Connell farm. This tree has a basal girth of thirty-three inches, and from its size would appear to be contemporaneous with the old Gardner trees. The original hedge of over three quarters of a century ago is still in existence, skirting a grassy tract of rather low ground which has come to be known as the thorn lot. The larger of these trees, gray and shaggy with age, must be rather more than twenty feet in height although many of them are scarcely over half that stature; a few are less than a foot in circumference near the base, but some of the trunks are of much greater size, the largest having a basal girth of nearly forty-five inches.

This introduced species comes into bloom about two weeks later than any of the native Nantucket thorns; first flowers June 17, 1908, June 15, 1910, June 16, 1911.

*CRATAEGUS CHRYSOCARPA Ashe.

C. rotundifolia of the manuals.

A single compact bush about eight feet high, formed of several trunks, grows in a roadside thicket close to the boundary between Quaise and Polpis. It was first observed June 9, 1909, then passing out of bloom, most of the corymbs having lost their petals. Close to it a group of the following species was white with freshly opened blossoms. No other individual of this thorn was met with, nor was any other white-anthered species found on Nantucket. This seems to be the earliest flowering of the island's native thorns. Its leaves and flowers are smaller than those of any of the other species.

*CRATAEGUS BICKNELLII Eggleston.

Discovered on Aug. 16, 1906, in Squam near the Quidnet road; a scattered group of treelike shrubs, the tallest about eight feet high. It was subsequently found in dry thickets or adjoining open ground in Shawkemo, Quaise, Polpis, and Squam, altogether at twelve or more separate stations in the northeastern quarter of the island. The largest examples are of the proportions of small trees, having a strong main trunk 12 to 14.5 inches in girth near the base. It flowers profusely, however, at a height of four to six feet while still having the conformation of a shrub. In full blossom June 7, 1908, June 9, 1909, June 10, 1911; first flowers June 4, 1909; red fruit Sept. 17, 1907. Flowering rather later than any other of the island's native thorns and more conspicuous when in full blossom. Flowers spreading 2–3 cm.; leaves more coriaceous and shining than those of any other of the native species and more deeply and acutely lobed; thorns stouter.

*CRATAEGIUS PRUINOSA (Wendl.) C. Koch.

Found in the same parts of the island occupied by *Crataegus Bicknellii* and in similar situations, but rather more widely spread. In only one instance were the two species seen actually together, although in several cases they occupied adjacent thickets. The nearest points to the town, where it was observed, are on the commons less than one and a half miles to the east, and near the shore at Shimmo Creek. On an exposed knoll, it here forms a close low growth among scrub oak and beech plum and was in full blossom

June 2, 1910. Farther east, in a more protected thicket beyond Abram's Point, it reaches a height of ten feet and seems to bloom a few days later; isolated groups occur also in thickets in Quaise, in Shawkemo, at Pocomo Head Pond, where it was passing out of bloom June 12, 1909, and at several localities in Squam. A small colony was also discovered on Tuckernuck, on a visit made to that island on June 17, 1911. Flowers spreading 1.75–2 cm.; the petals sometimes tinged with pink; leaves thinner than in any other of the Nantucket species, the thorns longer and more slender. Well developed green fruit was collected June 26, 1910. A tree growing at the border of Dyleave Swamp was perhaps the largest native thorn tree seen on the island, having a height of perhaps fourteen feet and a spread of six paces.

Specimens from several of the stations show rather well marked differences and may represent more than one species. Mr. Eggleston considers it unsafe to express an opinion on this point until mature fruit is collected. Specimems from the Abram's Point station differ from all the others in having slightly pubescent to loosely villous corymbs.

There is also a form of *Crataegus* on Nantucket that I have collected at three stations, in Shawkemo, Wauwinet, and Squam, which is almost certainly distinct from *Crataegus pruinosa*, having more deeply and acutely lobed leaves of firmer texture, stouter thorns, and rather larger flowers, the number of stamens sometimes less than twenty and even reduced to ten or twelve. All of these are characters that would be derivable from *Crataegus Bicknellii*, and it would seem to be quite possible that this ambiguous thorn is a hybrid of that species and *Crataegus pruinosa*. I do not myself, however, dare venture into the taxonomy of our wild thorns, and up to the moment of going to press have had no opportunity of submitting this case to the expert judgment of Mr. Eggleston.

*CRATAEGUS MACROSPERMA Ashe.

A group of about thirty small trees in a low thicket in Squam, forming a sort of miniature contracted grove, perhaps twelve to fifteen yards in longer extent. The trunks of the larger of these trees are straight and erect and mostly unbranched below, or with the branches ascending, so that it is possible to walk about

among them. There are also a few outlying small shrubs. On June 11, 1909, these trees were in full blossom above, the petals mostly fallen from the corymbs on the lower branches. Flowers 1.5–1.8 cm. in natural spread, the petals drying pinkish; stamens 5–7. More treelike than any other native Nantucket thorn, the largest examples ten to thirteen inches in circumference near the base and twelve to fourteen feet tall. Branches more ascending than in any of the other Nantucket species, the leaves less deeply lobed and on the upper surface more or less roughened with an hispidulous pubescence; corymbs and young fruit villous, the flowers with fewer anthers than any of the other species.

Note.—Mrs. Owen's catalogue includes "*Crataegus tomentosa* L. var. *punctata* Gray." It is scarcely probable that the species intended was any other than some one of those here reported.

PRUNUS SEROTINA Ehrh.

Common; not ordinarily of a greater height than ten or twelve feet and often much lower, in the most favorable situations reaching a height of eighteen to twenty feet. The bark of the trunk is sometimes unusually smooth and pale. In full blossom from before the middle of June until the end of the month.

PRUNUS MARITIMA Wang.

Very common, occurring in all parts of the island, even on Saul's Hills. In full blossom May 30 to June 15, 1909, and some blossoms remaining as late as June 22. Of unusually large size in a thicket near Tristram Coffin's homestead, the largest example about 10 feet tall and 15.5 inches around near the base.

*PRUNUS AVIUM L.

Spontaneous at several stations among young pine trees south and southwest of the town, also in pine scrub about two miles out on the old south road. No trees observed over ten feet in height and some bearing fruit when only three feet high.

*PRUNUS CERASUS L.

Here and there about long-abandoned farms and occasionally in wilder places, as in a thicket in Shawkemo with *Crataegus Bicknellii*, and among pines perhaps a mile southeast of the fair grounds; thicket in Squam.

*AMYGDALUS PERSICA L.

Spontaneous in waste spots about the town and occasionally at more distant points; on the bluff at Siasconset; one small tree on the old south road, about two miles from the town; a single tree about ten feet high at the border of a thicket in Squam.

*PRUNUS AMERICANA Marsh.

A small colony among pines on the road to Surfside, about a mile from the town, some of the trees very young, others about eight feet high; doubtless introduced. Still in blossom June 6, 1909.

Cryptomeric inheritance in Onagra*

C. Stuart Gager

(With plates 20 and 21)

In a previous publication[5] I have described an abnormal plant of *Onagra biennis* that appeared in the experimental plot of the New York Botanical Garden in a pedigreed culture following exposure to radium rays. The seed that produced the plant developed in an ovary exposed, before pollination, for 24 hours to the β and γ rays from radium bromid of 10,000 activity contained in a sealed glass tube. After this exposure the stigma was pollinated with unexposed, and, so far as known, normal pollen from another pedigreed individual of *O. biennis*. As described in the paper above cited, the seed gave rise to a plant that produced two shoot systems of equivalent value; that is, neither could be regarded as the main axis of which the other was a lateral branch. Apparently each half of the shoot was from a bud axillary in a cotyledon. Thus it was held that the anomaly was not a bud sport, in the ordinary sense of the word, "unless, keeping in mind that the plumule is a bud, we decide that there was an early bifurcation of the developing embryo, of such a nature that, after the cotyledons were laid down, there was a division of the growing point, accompanied by a separating out of antagonistic characters, and resulting in the formation of two morphologically as well as physiologically different shoots."

Each half of the seedling (*15a* of my cultures) developed in the usual way, forming a rosette in the seed pan, and subsequently, when planted out, sending up a cauline stem from the center of each rosette.

Taxonomic descriptions of the two plants are here repeated from the former paper,† and also an illustration of the young seedling (fig. 1).

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* Brooklyn Botanic Garden: Contributions No. 3.

† Loc. cit. 251.

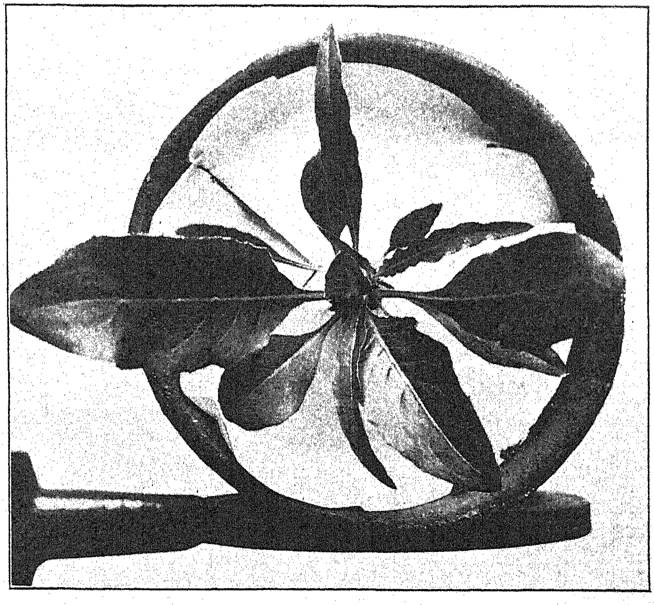

FIG. 1. *Onagra biennis*. Radium culture, no. 15a. Two rosettes, one narrow-eaved and one broad-leaved, on one taproot. Cf. FIG. 2, and PLATES 20 and 21.

15a broad

Rosette leaves finely and sparingly pubescent, the larger ones about 15 cm. long; blades spatulate to elliptic-spatulate, sinuate-dentate especially below the middle, often sharply or prominently so near the base, much longer than the petioles; stem 7 dm. tall, with elongate ascending branches on the lower part; stem leaves mostly spreading; blades narrowly elliptic, somewhat acuminate at the apex, sinuate-dentate; bracts similar to the stem leaves but smaller and usually broadest

15a narrow

Rosette leaves finely and sparingly pubescent, the larger ones 10–12 cm. long; blades almost linear, acuminate at both ends, undulate, somewhat longer than the petioles; stem 6.5 dm. tall, with relatively short ascending branches throughout; stem leaves mostly drooping; blades narrowly linear-lanceolate to almost linear, tapering to both ends, undulate-sinuate; bracts similar to the stem leaves but smaller; hypanthium about 45 mm. long; sepals about 30 mm. long, fully as long as the

below the middle; hypanthium about 35 mm. long; sepals about 25 mm. long, slightly shorter than the free portion of the hypanthium, the free tips in the bud subulate, 2.5–3.5 mm. long; petals about 15 mm. long, nearly truncate at the apex; capsules columnar, slightly narrowed to the apex, about 35 mm. long, much narrower than the bracts.

free portion of the hypanthium, the free tips in the bud long-subulate, 3–4 mm. long; petals about 20 mm. long, nearly truncate at the apex; capsules almost columnar, about 25 mm. long, slightly narrower than the bracts.

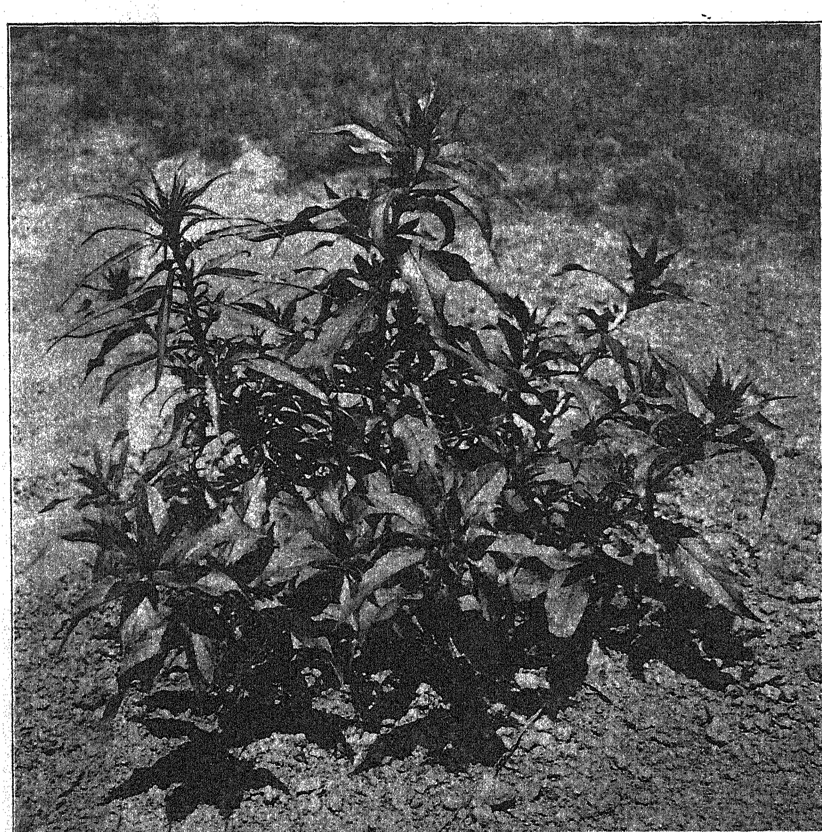

FIG. 2. *Onagra biennis*. Radium culture, no. 15a, showing two distinct shoots, morphologically unlike, on one root. The narrow-leaved shoot is at the left. Cf. FIG. 1, and PLATES 20 and 21.

The narrow-leaved branch bore flowers and opening buds for over a week after the broad-leaved branch had ceased to flower, thus pointing to a functional difference. FIGURE 2 shows the mature plant just before anthesis began. The greater vigor of the broad-leaved branch has obscured the equivalency of the two halves, so that the narrow-leaved portion *appears* in FIGURE 2 to be a lateral branch, arising from near the base of the other. Such, however, as pointed out above, was not the case. In PLATES 20 and 21 the morphological features are shown in detail.

Attempts to secure seed from *15a narrow*, either by its own pollen or by crossing it with *15a broad*, were not successful. The broad-leaved branch formed abundant seed when self pollinated, and also when crossed with pollen from *15a narrow*, but in the latter case only one seedling appeared in the seed pan. This plant manifested, throughout, only the characters of *15a broad*, and from it was collected an abundance of close-bred seed, for the purpose of testing whether or not a disjunction of characters would occur. The F_2 generation was grown in the experimental garden of the University of Missouri, at Columbia, Mo. Out of several hundred seedlings, not one showed the characters of the narrow-leaved grandparent, nor did any of these characters appear, either by bud sporting or otherwise, in plants that were allowed to mature.

The following explanations of the original anomaly appear plausible.

1. AN INJURY TO THE ANLAGE OF THE PLUMULE.
2. A QUALITATIVE CHANGE IN EITHER THE EGG OR SPERM that united to form the fertilized egg which gave rise to the plant.
   a. In the egg, due to exposure to the radium rays.
   b. In either egg or sperm, spontaneously, or independent of the radium.
3. SECTIONAL BUD-SPORTING IN THE ANLAGE OF THE PLUMULE.
   a. Due to causes resident in the cells (i. e., spontaneous), and irrespective of the radium rays.
      (1) The mutation occurred IN THE ANLAGE OF THE PLUMULE.
      (2) The mutation occurred in one of the germ cells, and the mutated characters first became active as the

plumule developed. This was due either to their separating from the normal characters during nuclear divisions, or to the normal characters becoming inactive.

b. As a result of the previous exposure to radium rays.

Suggestions 1 and 3 (1) above imply, of course, that the anomalous *Onagra* shoot was the expression of merely a somatic change in the plant body, not involving the germ cells at all, and that this is why the atypical characters did not reappear in the generation resulting from a cross between the unlike shoots; or, in other words, that the characters of the narrow-leaved shoot were not represented in the sperm cells of its pollen, and that these gametes were of hereditary content identical with those of the broad-leaved shoot. It is difficult, however, to conceive that such a condition could be realized, since the sperm cells, as truly as all the other cells of the narrow-leaved shoot, are the lineal descendants of the somatic cells which by the supposition were held to have sported. If, however, the characters of the narrow-leaved shoot were due merely to the fact that certain factors that were active in the broad-leaved shoot became inactive in the cell, or group of cells, that give rise to the narrow-leaved shoot, then it is thinkable that these factors became active again in the sperm cells and that thus the original condition was restored. But this does not seem very probable.

A much more probable solution than this emerges from the hypothesis of intracellular pangenesis*: namely, that the change resulting in the narrow-leaved shoot involved only the cytoplasm of the somatic or germ cells concerned, while their nuclei continued to carry, in the inactive state, the original hereditary deposit of the immediate ancestry. Whether the vehicle of this inheritance is conceived of as granular pangens, or as biogens of a definite kind, or as droplets of some enzyme or other chemical substance, or as a relationship merely, between certain bodies, or as any other kind of a "gene," does not affect the hypothesis of a change involving cytoplasm only. In this way an unaltered nuclear germ track might ramify through the plant, resulting in gametes perfectly typical so far as the nucleus is concerned. It is quite probable

* de Vries[16], 197–207.

that we have too much neglected the extra-nuclear cytoplasm in the consideration of the problems of heredity.

Whatever the mechanism of the change is conceived to be, the presumption is in favor of the radium rays as the determining antecedent condition, since such behavior, in the absence of this influence, has never been recorded. But that such a result as the double plant occurred at all is the significant botanical fact; the external "cause" of it is not so important.* Any explanation necessitates the formulation of some definite conception of the structure of protoplasm, and the mechanism of inheritance, and involves the consideration of several working hypotheses already elaborated.

Perhaps the most formal of these hypotheses is that of intra-cellular pangenesis. The essence of this now familiar hypothesis is that all living protoplasm consists entirely of pangens. Pangens are not chemical molecules, but masses of a higher order, having the power of nutrition and growth, of multiplication by division, and of becoming active or latent according to circumstances. When latent they are usually in the nucleus, and become active only when they pass out of the nucleus into the cytoplasm of the cell. These pangens are the bearers of the inheritable unit characters. A change in only the number of pangens causes fluctuating variations; the loss of one or more, or the formation of one or more new kinds of pangens underlies (*is*, in fact) mutation.† As de Vries[17] has stated, this conception formed the basis of the experiments described in his *Mutationstheorie*.

The bearing of this hypothesis on the double primrose-plant is almost too obvious to need stating. We may conceive that all the unit characters which found expression in both the broad-leaved and the narrow-leaved shoot were originally represented in either the egg nucleus or the sperm nucleus‡ that fused in the fertilization. As the fertilized egg developed, they were passed on by nuclear and cell division to all the cells of the embryo; and the apical meristem, at the time the plumule began to be laid down,

* Save as suggesting the possibility of artificially inducing mutative variations by means of radium rays.

† This protoplasmic change is called by de Vries "premutation".

‡ Or both, according to which one of the circumstances above suggested is regarded as the initiation of the change.

became differentiated into two unlike portions. In the cells of one half, the pangens fundamental to the distinguishing characters of the narrow-leaved branch became active, and the pangens fundamental to the distinguishing characters of the broad-leaved branch became latent or wanting. In the cells of the other half the reverse conditions obtained.

From the very nature of the hypothesis of intracellular pangenesis, this is, of course, a very formal explanation.

In chapter XIX of my memoir[5] on Effects of the Rays of Radium on Plants, I have suggested that the effects of the rays may be due to their influence, not directly on the living matter itself, but indirectly, on the enzymes or other non-living inclusions of the cells. This idea of the possible rôle of enzymes in morphogenic changes has been more elaborately worked out by Spillman,[12] who rejects the notion of a supermolecular, organic pangen in favor of, for example, an enzyme acting on some other chemical body, such as a chromogen. "All known Mendelian phenomena," says Spillman,* "may be explained as due to differences in the chemical constitution of the chromosomes in different groups." The failure of a character to appear is attributed to "the failure of a single chromosome to perform a particular function." A practically identical hypothesis was suggested independently by Holmes.[17]

Additional evidence that enzymatic action may be involved in mutation is found in the inference, made by de Vries[16] (p. 264), that mutating seeds remain viable longer than non-mutating ones; for it is well known that profound enzymatic changes occur in the aging of dry, resting seeds. Albo's[1,2] investigations indicate that the energy for the changes undergone by such seeds is enzymatic in origin, and he states that he was able to demonstrate that diastatic activity was either diminished or entirely wanting in seeds that had lost their capacity to germinate. Dry seeds of many families, and able to germinate, were found by Brocq-Rousseu and Gain[3] to contain a peroxydiastase, which the writers claim was never present in seeds that had lost the capacity to germinate. Miss White,[18] however, reports tests on the resting seeds of cereals, showing the presence in them of diastatic, ereptic, and fibrin-digesting enzymes, still active after a period of over

* Loc. cit. 246.

twenty years and after the germinating power of the seeds had been lost. According to Albo, the diastatic power is gradually lost, and it is not at all improbable that the decomposition products, resulting from the breaking down of some enzyme (or other substance, for that matter), may alter the hereditary content of the nucleus, in a manner similar to that effected by MacDougal[9,10] by injecting dilute solutions of various substances. This would offer a simple explanation of de Vries's observation, above referred to, that older seeds give a larger percentage of mutation than fresh ones. The accumulation of these disintegration products in the nucleus might inhibit or retard the action of certain enzymes involved in growth and development. Moore[11] has already suggested that our methods have heretofore been inadequate in taking account of only the end products of reactions. On the other hand, it is possible that new enzymes may develop and become the active agents in the alteration of the nucleoplasm.

In discussing the manner of origin of an *O. rubricalyx* mutant from an *O. rubrinervis* germ cell, Gates[6] (loc. cit. 204) dismissed de Vries's conception of pangens as "too formal an assumption to be accorded the dignity of an explanation," yet later on (ibid. p. 209) he speaks of "a fundamental change in the germ-plasm," without suggesting how we are to picture this "fundamental change." The rejected theory of de Vries is that of a fundamental change, only the fundament involved is clearly conceived and named by its author. It is difficult to understand how pangens are more "formal" than molecules, and it does not seem to the writer that the "formality" of the hypothesis is a priori a valid reason for rejecting it. It is merely a question of, first, does it agree with known facts, and, second, is there any actual evidence that such bodies as pangens really exist? The recent work of Strasburger[15] seems to indicate that there is, and the facts of development and heredity are such as would follow on the basis of pangenesis.

I do not wish to appear as arguing in favor of intracellular pangenesis as an expression of ascertained truth. On the contrary, I am rather inclined to think that it will have to be either rejected or profoundly modified when the truth is known, if it shall ever be known; but rejected, not because it is formal, but for lack of agreement with observed facts.

Lillie[8] has recently held that all hypotheses involving the existence of determinants or character units have served their time, and, referring to the work of Guyer and Montgomery, has emphasized the fact that germ-cell elements (chromosomes) may be segregated in nuclear and cell division. This, of course, is well known, and experiments on the effects of radium rays on nuclear division have shown that normal segregation may be greatly altered, and that even elimination of chromatin may be artificially induced in this way.*

I conceive it as quite probable that in the primordium of the epicotyl of the double primrose-plant such a segregation of chromatin material (possibly not entire chromosomes) occurred, accompanying or inducing the organization of two growing points, each the primordium of an epicotyl, and possessing an unlike relation between the hereditary elements of the cells. Not, necessarily, an unlike hereditary composition, for the characters unfolded in the F_1 and F_2 generations showed clearly enough that the characters of an organism that actually appear are a function—not alone of the inheritance of the cells, but of a relation that obtains between various inheritances, some being dominant, others recessive. The work of de Vries has clearly demonstrated that "hereditary potentialities" which exclude each other in the active state, may occur together when one or both are latent.

A qualitatively different chromatin content in the cells of the two growing points may have been the cause of the development of certain enzymes normally absent, or the repression of other ferments ordinarily present. Or these chromatin differences may have given some ferment a suitable body to act on in the one case and not in the other. Since such things as enzymes and fermentable substances are known to exist in plant cells it does indeed seem unnecessary to call in the assistance of an imaginary, new kind of body, until the ones already actually experienced have been shown to be inadequate.

Certain it is, however, as the rich mass of illustrations brought together by Darwin and by de Vries has previously emphasized, that the inheritance of a character and its expression are two entirely different things. The appearance of the double *Onagra*,

* Gager[5], Chapt. XVII.

and the character of its first and second filial generations, constitute a striking case in point.

BROOKLYN BOTANIC GARDEN.

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Explanation of plates 20 and 21

PLATE 20

Onagra biennis. Radium culture, no. 15a, broad leaf. The stigma was pollinated with pollen unexposed to radium rays after the ovary had been exposed for 24 hours to rays from radium bromid of 10,000 activity in a sealed glass tube.

FIG. *a*, flower bud, with bract, taken from a lateral branch; *b*, petal; *c*, nearly mature capsule, with bract (main stem); *d*, flower (minus corolla); *e*, leaf from main stem. Cf. PLATE 21, and FIG. 1 and 2.

PLATE 21

Onagra biennis. Radium culture, no. 15a, narrow leaf. For exposure to radium rays see legend of PLATE 20.

Induced and occasional parasitism

D. T. MacDougal

(WITH PLATES 22–25)

The results of some experiments in which regenerated cuttings of several succulent seed plants were made to become xenoparasites on various hosts have been published by the author during the last two years.*

Regenerated cuttings of vines and of cacti were inserted in cavities prepared for them in the bodies of other plants used as hosts, being held in place by plaster of Paris seals, and the course of growth followed for extended periods. A consideration of the morphological and chemical features of the parasite and host of all such nutritive couples was then made, to ascertain what factors made it possible for one plant to become dependent or parasitic on another. It was notable that outside of the single anatomical feature of the possession of a water balance or accumulated supply of fluid, no morphological characters might be taken as indispensable in possible parasitism. It might be seen, however, without recourse to experimental results, that certain habits of growth, of rapid formation of wound tissue and of excretions might well prevent a plant from being fastened upon by a parasite. The chemical examinations showed that when one form was induced to become parasitic upon another, the host in every case had a sap with a lower osmotic activity than that of the xenoparasite. At the same time a cutting of a species with high osmotic pressure might fail to establish itself on another plant of lower activity. This was especially true of the sahuaro, or great tree cactus (*Carnegiea*). Its succulent stems, with soft subepidermal structures, offered most inviting conditions to the experimentalist, but the acrid secretions poured into wounded cavities generally prevented inserted cuttings from withdrawing solutions that might serve as

* See The condition of parasitism in plants. Carnegie Inst. of Washington. Pub. No. 129. 1910; The making of parasites. Plant World **13**: 207. 1910; and An attempted analysis of parasitism. Bot. Gaz. **52**: ——. 1911. (In press.)

nutriment. The sole survivors on this plant as host are two opuntias, one a cylindrical and the other a flattened form, while the failures may be numbered by the score.

Opuntias with mucilaginous juices also offered unfavorable conditions for parasites. While this work was being done, estimates of the acidity of the sap of various cacti were made of specimens taken at random without regard to the time of day, exposure to light, or temperature. No connection could be established between acidity and parasitism with such data at hand. Recently, however, Prof. H. M. Richards has carried out some work on respiration at the Desert Laboratory, in which it was found that the acidity of a cactus is four times as great at sunrise as late in the afternoon, and that the amount of acid present is affected in an important manner by the rise and fall of the temperature. These variations together with the effect of the changing acidity upon the absorptive capacity of the mucilages and of other colloids, such as those of the cell walls, might account for the entire lot of experimental cases presented. Indeed, it is not too much to say that when all of these factors are properly integrated, the possibility of dependent parasitism between two species might be predicted with fair certainty.

After the completion of the last article dealing with this subject a few of the experimental parasites still remained active. The description of the further history of these arrangements and of some unusual conditions of this kind found among native plants constitute the purpose of the present paper.

A case of parasitism of *Opuntia Blakeana* on *Carnegiea gigantea* was discovered in Roble's pass, 7 miles southwest of the Desert Laboratory, on March 19, 1911, and a visit was made to it a few days later in company with Prof. H. M. Richards for the purpose of making a detailed examination and photographs.

The sahuaro was a tall specimen with four branches, being about two hundred years old. The largest branch was about 12 feet long and arose from the trunk about 7 feet from the ground. Germination of an *Opuntia* seed had evidently taken place in the axil, and the roots had penetrated the corky layers in the angle. The growth of the opuntia had resulted in the development of two main stems, one consisting of two and the other of three joints,

which showed some atrophy. The season of 1910 had been very dry and a small cylindrical branch had arisen from the basal cylindrical part of the stem, the terminal section of which had died back. (See PLATE 22.)

The large branch, which was over a foot in diameter at its base, was cut away and the roots of the opuntia dissected out, a task of some difficulty. Some of the rootlets reached a distance of a foot from the base of the opuntia, and while many of the branches partly encircled the base of the branch of the sahuaro, yet one main root and its branches had penetrated directly inward into the tissues of the greater cactus to a depth of over six inches, being completely submerged and cut off from the air. The advance of the root had been followed by the death of the cortical cells of the host and by the formation of scar tissue enclosing the parasitic roots, and then secondary root formation had followed, which resulted in a dense mesh of fibrils, none of which were in actual contact with living tissue. (See PLATE 23.)

The contact thus made with the *Carnegiea* was undoubtedly the source from which the chief supply of solutions was obtained. The remainder of the root systems was in such position that the moisture collected in the sinus of the branch and the stem might be absorbed, but as the amount of this liquid would be small and would be available for only a few hours during the entire year, it is all but a negligible quantity in the nutrition of the opuntia. A transverse section of a portion of the cortex enclosing a penetrating root would show this organ surrounded by a flattened tube of corky tissue derived from the cortex of the host. The folds of this tube extended for several millimeters from the root.

The parasitic opuntia was brought away intact and set in the soil in the terrace of the Desert Laboratory to allow observation of its further development, and under autophytic conditions. Similar experience with a plant taken from a *Parkinsonia* showed an abrupt alteration in the amount, rate of growth, and form of the flattened stems. [Bot. Gaz. **52**: —. 1911. (In press.)] So great was the difference that the identity of the species was mistaken previous to its cultivation in the ground under the customary conditions.

An *Opuntia discata* growing from the trunk of *Acacia* was reported by Dr. W. A. Cannon in 1909 and a special excursion was

made to examine the arrangement in April 1911. The original photograph, from which a drawing has been made, showed a heavy basal stem of the opuntia issuing from a knot hole in the trunk of the tree and bearing two branches, one consisting of one joint and the other of three. (PLATE 24.) The size of the stem of the opuntia would indicate that it was perhaps fifteen or twenty years old, but the limited supply of food material to be obtained from the host had operated to the loss of other flat joints that may have been formed from time to time. The more recent observation showed a main horizontal stem of four joints, from which were arising a number of new joints. A basal branch of three joints was dead and was all but detached from the plant. A single upright joint bore a small young joint rapidly enlarging. Another upright joint and the two terminal joints of the horizontal stem were in a dying condition. It seems probable that the plant yearly gives rise to more branches than may be maintained by the supply of solution derived from the host and that the arid after-summer of 1911 will be the occasion for the death of some of the joints that are being formed in the growing season of the earlier part of the year. (PLATE 25.)

It was not deemed advisable to dissect this arrangement until further observations had been made, but it is probable that the development of the roots of the opuntia follow the formation of a cavity in the trunk of the acacia by the decay of the wood, and that the roots of the intruding cactus operate to cause or hasten this integration. A similar case of *Opuntia* on *Parkinsonia* has been previously described. (See Publication 129, Carnegie Inst. Washington, 1910.)

A plant of *Opuntia Blakeana* set in the side of a trunk of *Carnegiea* early in 1909 has continued a fairly even existence although no growth in the way of formation of new joints has been seen. The plant consisted of a basal cylindrical section and a terminal oval joint. The plaster, which was used to hold the xenoparasite in place when first arranged, has gradually crumbled away, but the parasite is held firmly in place by its own roots. As has been previously noted, some thickening of the basal portion of the stem is noticeable. The amount of growth to be expected from parasites is always less than that of autophytic individuals.

That some actual parasitism or derivation of nutriment takes place, is evident from the fact that similar small plants separated from the soil and exposed to the same climate desiccate within a single season, while this preparation has survived three hot summers. A small individual of *O. versicolor* set in the trunk of a *Carnegiea* in the spring of 1909 is also robust and thriving, having undergone considerable thickening of the stem, one branch, and the exposed portion of the roots. Both of the above preparations give every appearance of being permanent during the ordinary life cycle of the individuals.

Some of the most important experimental results were obtained by using regenerated cuttings of a grape (*Cissus laciniata*), from the region of Tehuacán, Mexico, as a parasite, and some new arrangements were set up early in 1911. This plant undergoes secondary thickenings of the stems in such manner that portions near the ground, or partially imbedded in it, attain a diameter of several inches, and contain large balances of water and food material. Oftentimes the thickening will take place in portions of the climbing stem many feet from the ground. The thinner portions of the stem die upon the cessation of active growth, with the consequence that sections of thickened stem may be supported by the dead tendrils high above the substratum. In some instances such thickened sections will be held by a second vine, clasped by the tendrils. The beginning of activity in these suspended stems usually consists in the formation of long adventitious roots which hang down and are capable of making a length of one or two yards. If the ground is reached, new supplies ascend through the aerial roots and the plant survives. Many of the thickened sections are held at such elevation that the supply of water and material does not suffice for the construction of roots of a length that may reach the ground, and consequently the isolated members perish. Similar behavior was exhibited by plants in the glass house at the Desert Laboratory. It is evident that such suspended sections offer some chance of contact or penetration of other living plants, thus setting up parasitism, and the previous experiments showed that this grape might be made parasitic on *Opuntia*, *Echinocactus*, and sometimes on *Carnegiea*.

A number of new preparations were made in April, 1911, in

which cuttings were inserted in resting potato tubers and also in joints of *Opuntia Blakeana*. Late in May it was found that nearly all of the cuttings in potatoes were forming short basal roots with still shorter clubshaped branches, and the cavities about them were being enlarged rapidly by decay. A few cuttings were sending out aerial roots from the upper ends. These were all transferred to joints of *Opuntia*, some in the glass houses and some in the open, late in May, 1911. All in the glass house were alive, and about half of those in the open, in August, 1911. The amount of leaf development was small and the growth of the shoots offered no features not previously described.

It is notable that in these, as well as in all previous experiments dealing with this subject, very little evidence of forcible penetration of the tissues of the host was seen. Whether by the previous action of bacteria or by excretions from the xenoparasite, the invading roots never actually bored through masses of living cells. In all cases the layer of tissue, one or more cells in thickness, nearest the roots was found to be dead and more or less disintegrated. Peirce, in his earlier work on this subject, cites instances in which roots of *Brassica* and *Sinapis* actually penetrated among living cells by a comparatively rapid growth. (Das Eindringen von Wurzeln in lebendige Gewebe. Bot. Zeit. 52^1: 169. 1894.)

It is notable that the experiments included in this research, which has been carried on for four years, were made under extremely arid conditions, in which the transpiratory loss was high. The plants that were induced to live as parasites were therefore under the double burden of securing nutriment from a host, which furnished a substratum offering physical conditions widely different from those which their absorbing organs ordinarily encounter, and of maintaining their own turgidity as a necessary condition of growth and other constructive processes. As has been amply demonstrated, the change from an autophytic to a parasitic condition is one that may be readily made by many species. The distributional movements of plants, which are constantly bringing new pairs into contact, would operate to bring eligible parasites and possible hosts together and cases of newly originated dependent nutrition may be expected from time to time.

The instances reported in this and previous papers are of this character. The instances cited were found by the examination of a small number of species. A comprehensive survey of the root habits of any region would doubtless reveal a large number of parasitic arrangements of various kinds as yet unknown to us. The recent discovery of the parasitism of *Krameria* by Dr. Cannon was made by the use of such methods, and has added a tenth to the list of families with parasitic members.

Desert Botanical Laboratory,
Tucson, Ariz.

Explanation of plates 22-25

PLATE 22. *Opuntia* in the angle of branch and stem of sahuaro. Drawn from a photograph.

PLATE 23. Detail of roots of *Opuntia* parasitic on sahuaro. (See PLATE 22.) Drawn from a photograph.

PLATE 24. *Opuntia* on *Acacia*. Drawn from a photograph made in 1909 by Dr. W. A. Cannon.

PLATE 25. *Opuntia* on *Acacia* in 1911. Photograph by the author.

A new variety of Carex lupulina

EARL E. SHERFF

(WITH PLATE 26)

In the summer of 1909, the writer's attention was attracted by some peculiar sedges growing in a small stretch of swamp east of Thread Lake, at Flint, Michigan. In most respects they resembled *Carex lupulina* Muhl., but differed from the species proper in having white-margined leaves (including bracts) and scales and white-striped perigynia. Muhlenberg,* in his original description of *Carex lupulina*, makes no mention of this form.

At first a pathological cause was suspected of producing the peculiar color design. Typical *Carex lupulina* growing interspersed with the form was studied, and in no case was the color found to vary toward that of the form. Likewise, a study of many specimens of the form failed to show an intermediate stage between its color and that of the species. And further, where the stolons of both crossed and intertwined with each other, it was found that plants from any individual stolon or system of stolons were uniformly either all of the form or all of the species proper. In other words, the two were sharply distinct. Had the cause been pathological, it is not improbable that cases would have occurred in which the cause was but weakly operative and the demarcation hence less distinct. Especially would an intermediate stage be expected in the young plants vegetatively produced by stolons and established some distance from the parent plants. Such intermediate stages being absent, it thus appears certain that we have to deal with a definite, fixed form and not with a temporary form induced by some obscure pathological factor.

Unfortunately, material had scarcely been gathered for specimens when the level of Thread Lake was raised several feet by the reconstruction of the dam at its outlet, extending the lake back over and flooding the area occupied by the sedges. This

* Mühlenberg ex Willd. Sp. Pl. 4: 266. 1805; Schkuhr, Riedgr. 2: 54. *t. Ddd. f. 123 & t. Jiii. f. 194.* 1806.

has made it impossible to secure more material for experimental work with achenes and stolons, as all of the sedges were destroyed. The original specimens have been deposited with the herbarium of the Missouri Botanical Garden (type), the Gray Herbarium, and the herbarium of the Field Museum.

The new plant is here introduced as a formal variety and given the name

Carex lupulina albomarginata var. nov.

Carex formae typicae dissimilis, foliis et squamis albomarginatis, perigyniis albolineatis.

To Dr. Wm. Trelease of the Missouri Botanical Garden and to Dr. J. M. Greenman of the Field Museum the writer's sincere thanks are due for a critical examination of material, also to Professor C. E. Barr of Albion College for the careful execution of the accompanying plate of illustrations.

CHICAGO, ILL.

Explanation of plate 26

A, upper portion of mature plant; B, lower portion; C, portion of leaf; D, perigynium; E, achene; F, pistillate scale; G, staminate scale.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1910–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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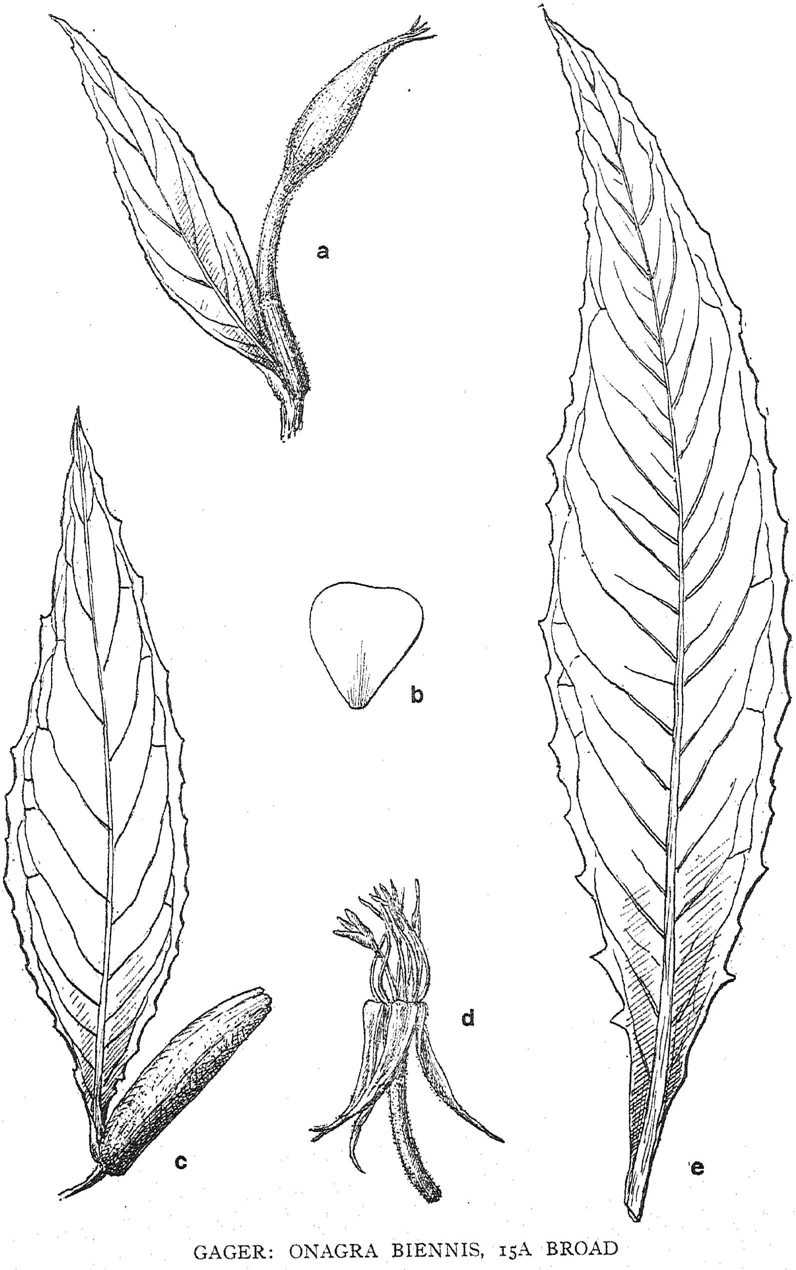
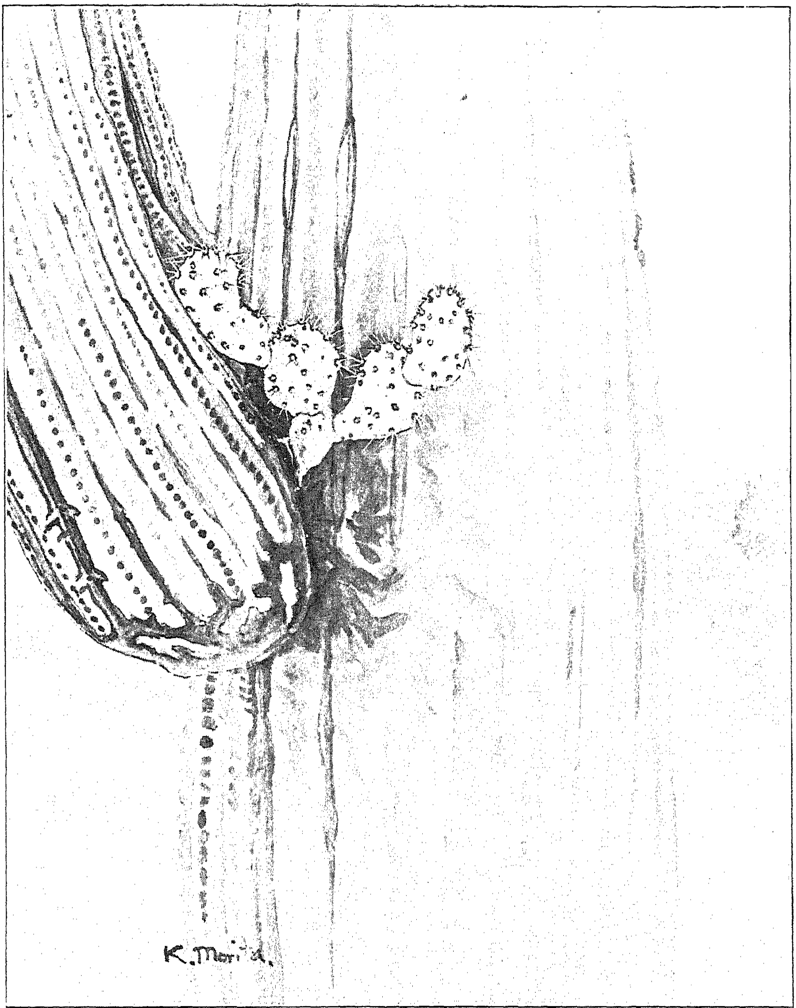
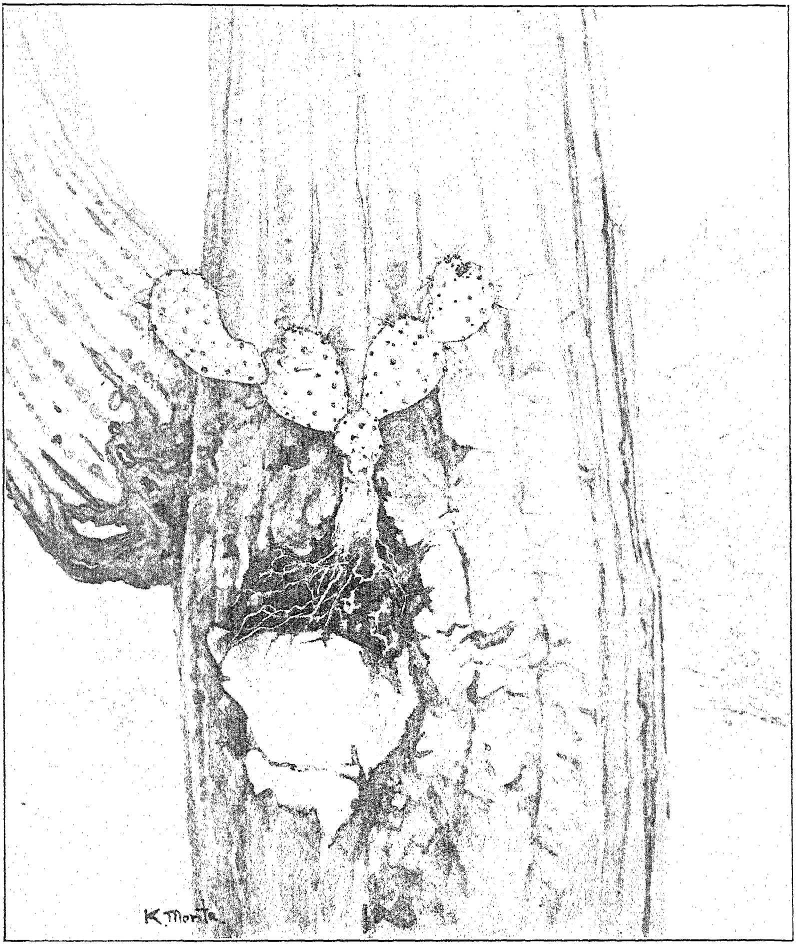


GAGER: ONAGRA BIENNIS, 15A BROAD

GAGER: ONAGRA BIENNIS, 15A NARROW



MACDOUGAL, OPUNTIA ON SAHUARO



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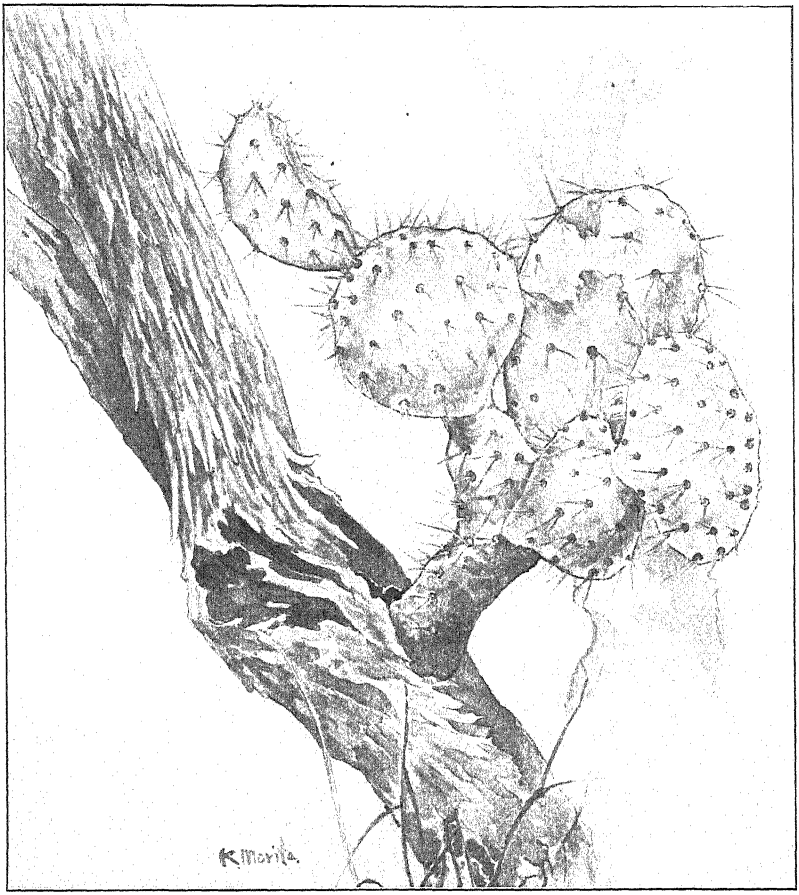

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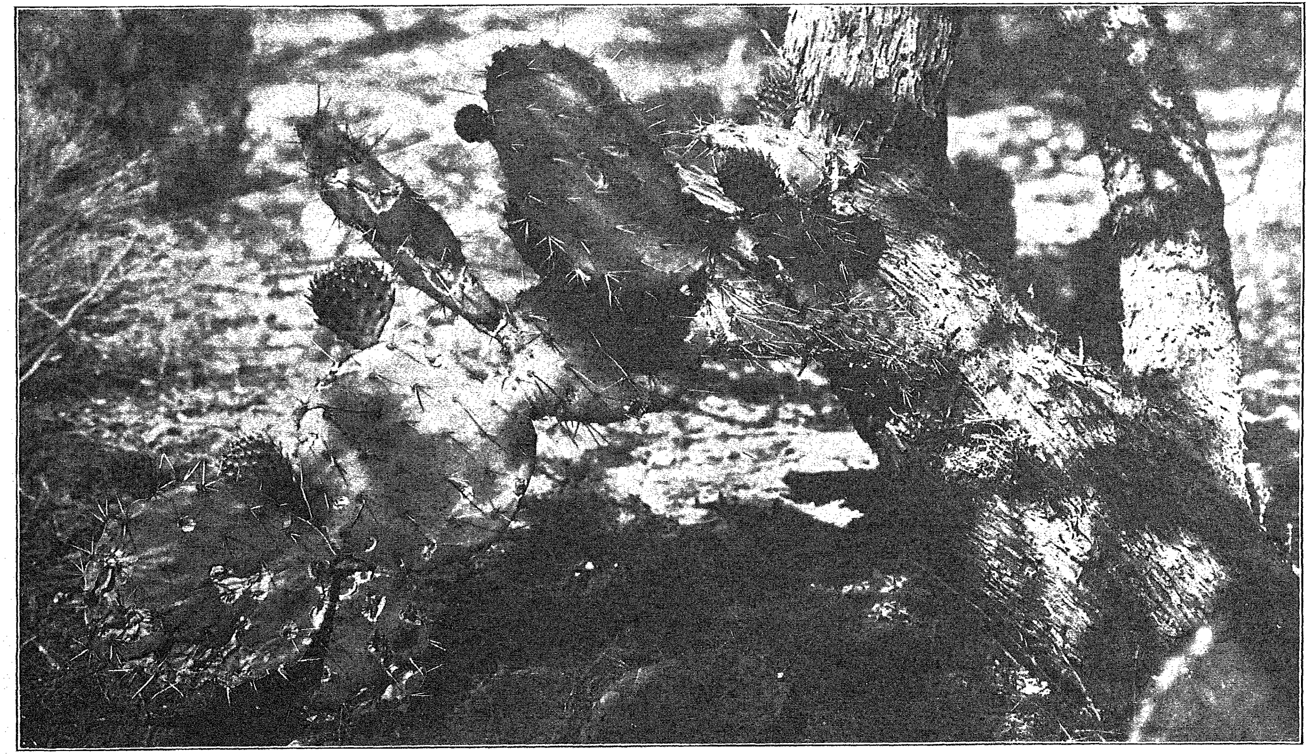

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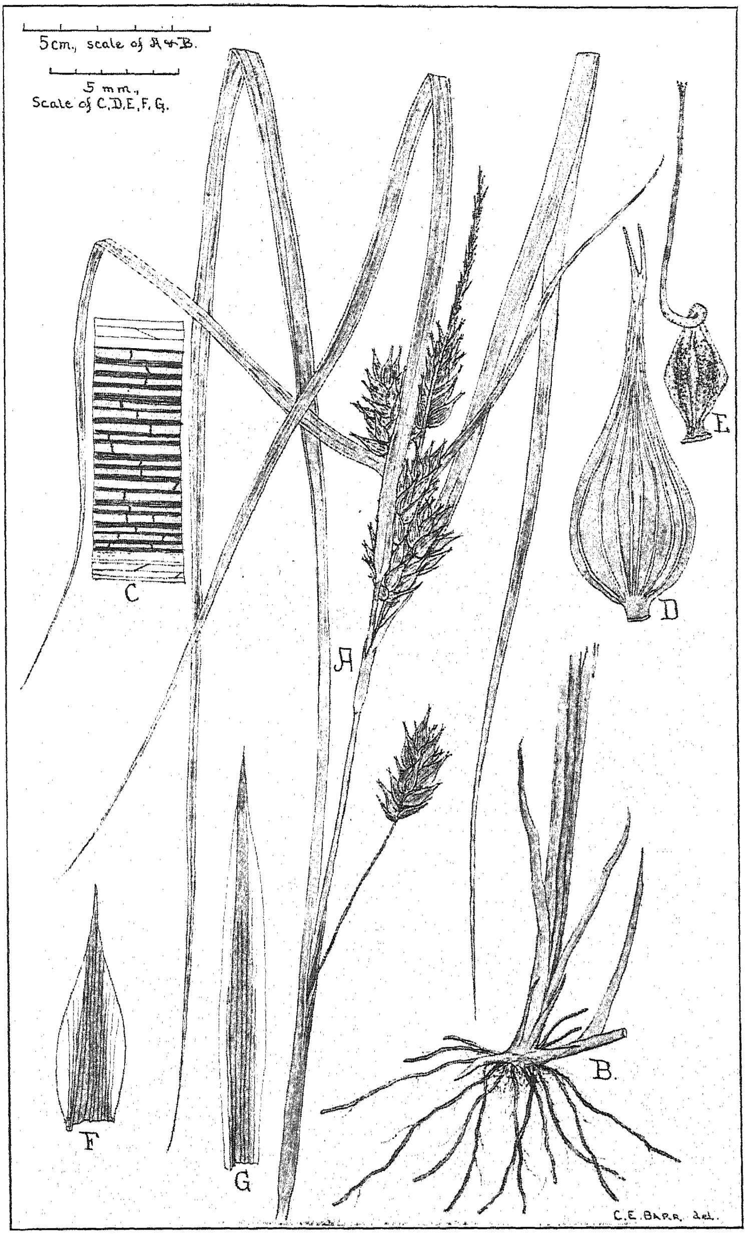

CAREX LUPULINA ALBOMARGINATA Sherff

Vol. 38 No. 11

BULLETIN

OF THE

TORREY BOTANICAL CLUB

NOVEMBER, 1911

Phycological studies—V. Some marine algae of Lower California, Mexico

MARSHALL AVERY HOWE

(WITH PLATES 27–34)

So far as the writer is aware, the only paper in which the algae of Lower California (Baja California) have been described or noted is one by M. Paul Hariot, published in 1895.* In that paper seven species, five marine and two from fresh water, were recorded; of the seven, three were described as new. In our list published below, twenty-four species are definitely named and three others have been referred simply to genera, and as these are all different from the seven recorded by M. Hariot, we have now, for the beginnings of our knowledge of the algal flora of Lower California, some evidence of the existence there of at least thirty-four species. The fact that none of the collections thus far made duplicates any of the others even as to a single species may possibly be taken as an indication that the algal flora of this region, when better known, may prove to be rich and varied. The present paper is based primarily on a collection made at La Paz on February 28, 1911, by Señor G. J. Vives, and submitted to the writer for determination by the late Dr. Pehr Olsson-Seffer, chief of the botanical section of the Departamento de Exploración Biológica of the agricultural bureau of the Mexican government. Señor Vives' collection includes eighteen species, of which seven are described below as new. In addition to this gathering, a collection of six

* Algues du Golfe de Californie recueillies par M. Diguet. Journal de Botanique 9: 167–170. 1895.

[THE BULLETIN for October 1911 (38: 447–488. *pl. 20–26*) was issued 4 N 1911.]

species made in February, 1904, by Dr. D. T. MacDougal, in San Felipe Bay, 500 miles or more north of La Paz and near the head of the Gulf of California, is reported upon; of these we have ventured to propose one species as new. In the list are included also three other species from La Paz, which came to the herbarium of the New York Botanical Garden in 1904 through the purchase of the herbarium of Dr. C. L. Anderson, of Santa Cruz, California.

CHLOROPHYCEAE

ULVA FASCIATA Delile, Fl. Égypte 153. *pl. 58. f. 5*

La Paz, *Vives 12* and *24*.

The specimens appear to approach Setchell's forma *expansa*. The thallus is only 35–55µ thick and the cells in the older parts are often subquadrate in cross section, but in these respects the plants do not differ much from the New York Botanical Garden copy of Phyc. Bor.-Am. LXXVII, distributed as *Ulva fasciata* forma *expansa* Setchell.

ULVA LACTUCA RIGIDA (Ag.) Le Jolis, Liste Alg. Mar. Cherbourg 38. 1863

Ulva rigida Ag. Sp. Alg. 410. 1822.

San Felipe Bay, *D. T. MacDougal*, Feb. 1904.

Thallus 36–42µ thick, brownish, becoming almost livid.

(?) ENTEROMORPHA INTESTINALIS (L.) Grev. Alg. Brit. LXVI, 179. 1830

La Paz, *Vives 16*.

Inconspicuously proliferous near base, the proliferations often short and spinescent; membrane 40–54µ thick; cells mostly 13–25µ in diameter, rather thin-walled, in cross section of thallus about 40µ long, exclusive of outer walls; attached to the stalks of a Sertularian (?) animal.

ENTEROMORPHA LINZA (L.) J. Ag. Till Alg. Syst. 3: 134. 1882

Ulva Linza L. Sp. Pl. 1163. 1753.

San Felipe Bay, *D. T. MacDougal*, Feb. 1904.

The plants are small and unusually narrow (4–10 cm. long, 1–6 mm. wide) and their margins are plane or nearly so. They

are rather difficult to distinguish from *Enteromorpha compressa* forma *simplex* Wittr. & Nordst. (Alg. Exsicc. *326*), but the two layers of the thallus appear to separate less easily in the upper broader parts, the marginal cells in a cross section are more elongate and more radiately disposed, and the cells in general are more distinctly in lines in the lower parts. No trace of branching has been observed.

Cladophora MacDougalii sp. nov.

Rather stout, coarse, and rigid, in strict tufts, dark- or yellowish-green, 10–17 cm. high; main filaments 135–310μ in diameter, sparingly dichotomous below the middle of the tufts; branching in median and upper parts lateral, the branches erecto-patent, secund, occasionally alternate, or very rarely opposite, becoming more or less secund-pectinate toward apices, the main axes commonly excurrent beyond the last lateral branch as rather rigid tapering prolongations 10–40 cells long; the ultimate lateral branchlets 75–110μ in diameter, about one half the diameter of the filaments from which they spring, usually 3–7 cells long, in most cases gradually tapering from near the base, subacute or blunt, commonly rather rigid; cells in extreme basal parts 6–15 times as long as broad, in median and upper parts 1–4 (mostly 1½–2½) times as long as broad, usually a little constricted at the septa and appearing quite strongly constricted when dry. [PLATE 33, FIGURE 7.]

San Felipe Bay, *D. T. MacDougal*, Feb. 1904.

The present species is evidently allied to both *Cladophora Hutchinsiae* (Dillw.) Kütz. and to *C. ovoidea* Kützing, but is not satisfactorily identified with either. In size it resembles *C. Hutchinsiae* (type from Ireland), but it is more rigid and much more strict in habit of growth; dichotomies are rare above the middle of the tuft, while in *C. Hutchinsiae* they commonly persist almost to the apices; the ultimate lateral branchlets in *C. MacDougalii* are much more slender than the axes from which they arise, having usually, in their middle parts at least, only half the diameter of the parent filament, while in *C. Hutchinsiae* the corresponding branchlets are as a rule only slightly less stout than the filament from which they spring; in *C. MacDougalii* ultimate lateral branchlets of 1 or 2 cells in length are extremely rare, 5 to 7 cells being the prevailing number, while in *C. Hutchinsiae* branchlets of 1 or 2 cells are very common.

Cladophora ovoidea Kütz. (type from the island of Föhr, North Sea) has, according to its original describer, primary filaments that are 1/20''' (112μ) thick and upper branches 1/40''' (56μ) thick,* and his later† figures of the species bear out this general description of its dimensions, though one of the cells of the main filament figured, according to the magnification given, reaches a diameter of 150μ. We have seen no European specimens of *C. ovoidea*, but are unwilling at the present time to identify with this species a Lower California plant with filaments and branches averaging twice as thick as those of the plant described and figured by Kützing, and with filaments so little constricted at the septa (in a soaked-out condition, at least) that no one would think of describing any of the cells as "ovoid" (Kützing, Phyc. Gen. 266). Also, according to Kützing's figure, the branching in *C. ovoidea* is more fasciculate than in *C. MacDougalii*, the ultimate lateral branchlets are less tapering and less rigid, and the main axes do not show the long-excurrent prolongations of the Baja California species.

CLADOPHORA TRICHOTOMA (Ag.) Kütz. Sp. Alg. 414. 1849
Conferva trichotoma Ag. Syst. Alg. 121. 1824.

Fragments referable to this or to some closely allied species are mixed in with a specimen of *Centroceras clavulatum* from La Paz in the herbarium of the New York Botanical Garden, ex herb. C. L. Anderson, collector unknown. The intertangled filaments are 190–300μ in diameter, di- or trichotomous at nearly every joint, with occasional short and blunt lateral branches 1–3 cells long and of scarcely less diameter than the parent filament; cells mostly 2–5 times as long as broad, usually constricted at the septa, the upper often ovoid. The plants are rather coarser and the cells are relatively shorter than called for by Kützing's description and figures for the species in question.

HALIMEDA DISCOIDEA Decaisne, Ann. Sci. Nat. II. 18: 102. 1842.
Howe, Bull. Torrey Club 34: 495–500. *pl. 25. f. 11–20; pl. 26.* 1907

La Paz, *Vives 4*.

The segments are here mostly quadrangular-oblong or cuneate-

* Kützing, Sp. Alg. 393. 1849.

† Kützing, Tab. Phyc. 3: 26. *pl. 92. f. 1.* 1853.

obovoid, the longer axis being nearly always in the longitudinal or vertical plane rather than in the transverse. As in Hawaiian specimens, the utricles of the subcortial layer are smaller and less bullate than in the plants of southern Florida and the West Indies, but they have a maximum diameter of 68–175μ and are always much larger than the peripheral utricles; they also form a compact flat-topped stratum, very different from anything that occurs in *H. Tuna*. The firmly coherent, often interlocked and fusing peripheral utricles, and the light calcification, together with the characters previously mentioned, leave no doubt as to the correctness of identifying the plants with *H. discoidea*.

The finding of a *Halimeda* on the coast of Lower California is of particular interest in extending our knowledge of the distribution of this genus. So far as is known to the writer, the only previous record of the occurrence of a *Halimeda* on the Pacific coast of the American continents is that given by Miss Ethel Sarel Barton [Mrs. Gepp] in her monograph of "The Genus *Halimeda*," where, under the stations for *Halimeda Tuna*, is given "Payta, Peru, *Sinclair*."

CODIUM TOMENTOSUM (Huds.) Stackh. Ner. Brit. XXIV. 1797

Fucus tomentosus Huds. Fl. Angl. 584. 1778.

La Paz, *Vives 8* and *14*.

The specimens from Baja California communicated under the above numbers are a little more rigid than is usual in *Codium tomentosum*, and the walls of the peripheral utricles are for the most part conspicuously thickened at their apices, being there commonly 8–27μ thick, though occasionally only 3–4μ. We find no trace of a mucro even in the younger parts and can discover no sufficient ground for considering the plants distinct from *C. tomentosum*, with which they agree well in size and habit. The thickened apices of the utricles are slightly suggestive of those of the Australian *Codium galeatum* J. Ag., but they are not contracted-umbonate as in that species and the plants have not the size and habit of that species. Certain Jamaican specimens which we have referred to *C. tomentosum*, sometimes have the apical walls of the peripheral utricles even more thickened than in these plants from Lower California, and European specimens occasion-

ally show the same character. In this latter connection may be mentioned especially Hohenacker's Meeralgen, *no. 497*, from Cherbourg, distributed as *Codium tomentosum* var. *proliferum*, and *no. 35* of Mary Wyatt's Algae Danmonienses. *No. 628* of the Phycotheca Boreali-Americana, from La Jolla, California, issued as *Codium Lindenbergii* Binder, is, so far as we have seen it, a somewhat coarser and less copiously branched plant than those from Baja California, and its peripheral utricles are scarcely thickened at the apex. If it had been collected in England, we suspect that it would have been referred to *Codium tomentosum* without serious question. The plants issued under this number, so far as we have seen them, scarcely show evidence of flattening beyond that resulting from pressure. They are certainly very different in habit from plants of the South African *C. Lindenbergii*, which is conspicuously flattened throughout, with the possible exception of the stipe, and has segments often 2–3 cm. wide. The utricles of the Baja California plants, it may be remarked, are clavate, obovoid-clavate, truncate-clavate, or pestle-shaped, 82–165μ in greatest width, and 380–500μ long.

Codium decorticatum (Woodw.) comb. nov.

Ulva decorticata Woodw. Trans. Linn. Soc. 3: 55. 1797.
Codium elongatum Ag. Sp. Alg. 1: 454. 1822.

La Paz, *Vives 17*.

The plants reach a length of 5 dm., are sparingly branched, and, in the older, are flattened now and then under the dichotomies; the peripheral utricles are obovoid or broadly clavate, thin-walled, obtuse, 137–520μ in maximum width, and 500–700μ long.

The identity of Woodward's *Ulva decorticata* with *Codium elongatum* was admitted by C. Agardh himself at the moment of proposing the name *C. elongatum* and has been acknowledged also by Kützing. We have not seen Woodward's specimen and do not know that it exists, but his lengthy and rather detailed description can leave students of *Codium* in no reasonable doubt as to what he actually had. His failure to recognize its affinity with "*Fucus tomentosus* Huds." and his statement that "in substance it differs from all other known marine Algae" appear a little strange, yet from Goodenough and Woodward's paper on the

British Fuci, published in the same volume of the Transactions, it would seem that these authors were not very familiar personally with "*Fucus tomentosus*" and, furthermore, that they considered it "very doubtful whether it may not belong to the genus *Ulva*." Agardh doubtless thought that he was improving on the specific name in substituting *elongatum* for the inapt and more or less misleading *decorticatum*, but under the prevalent rules of procedure of the present day, there seems to be no sufficient reason for ignoring what is apparently the oldest tenable specific name.

Harvey and some other writers have doubted the specific distinctness of what has been known as *Codium elongatum*, considering it a form of *C. tomentosum*. But in its usual form it is so different from *Codium tomentosum*, and ambiguous conditions are so few that it seems worth while, for the present at least, to maintain its specific rank. Its elongate and sparingly branched habit, its more or less pronounced flattened expansions below the dichotomies, and its larger utricles, are commonly quite sufficient to distinguish it from *C. tomentosum*. In this connection, however, it is of interest to note that the apparently original specimens of *C. elongatum* Ag., preserved in the Agardh herbarium, do not show particularly large utricles (they are 110–225μ in greatest width), and the dilations under the dichotomies are not remarkably pronounced, reaching a width of scarcely 2 cm. In specimens of our collecting in Bermuda the dilations sometimes have a width of 10 cm. or more.

PHAEOPHYCEAE

COLPOMENIA SINUOSA f. TUBERCULATA (Saunders) Setch. & Gard. Univ. California Stud. Bot. 1: 242. 1903

Colpomenia tuberculata Saunders, Proc. California Acad. Sci. III. 1: 164. *pl. 32. f. 1–3.* 1898.

La Paz, collector unknown. The specimens were sent to Dr. C. L. Anderson from the California Academy of Sciences, with the information that they had been used for packing. The brown, coriaceous thallus forms mats 10–20 cm. wide. Some parts of the thallus are nearly smooth, some parts bear wartlike excrescences, and others are drawn up into subconical, bullate, or finger-shaped processes sometimes 1–2 cm. long.

COILODESME ————?

La Paz, *Vives 18c.*

Poor and fragmentary material, but it seems to be closely related to *Coilodesme californica* (Rupr.) Kjellm.

SARGASSUM ————?

La Paz, *Vives 18d.*

A fragment of a plant of the *Eusargassum* section, with thin linear-lanceolate serrate-ciliate leaves 6–8 cm. long and 7–12 mm. in greatest width; cryptostomata inconspicuous or wanting; leaf margins here and there approaching a biserrate condition.

SARGASSUM ————?

La Paz, *Vives 1.*

A single plant a meter or more in length, sterile or with very immature receptacles. Resembling *Vives 18d*, but the lanceolate or linear-lanceolate leaves (2–9 cm. long, 5–14 mm. in greatest width) have much more conspicuous cryptostomata. The texture of the leaves is thin-membranous and the margins are irregularly serrate, the teeth often terminating in soft somewhat cilium-like points. The vesicles are subglobose and muticous, the largest attaining a diameter of 6–8 mm. Both this and 18*d*, which is possibly a form of the same thing, are quite different from *Sargassum Liebmanni* J. Ag. and *S. Agardhianum* Farl., which, so far as we are aware, are the only two species of *Sargassum* that have thus far been described from the Pacific coast of North America. The plants suggest broad-leaved forms of *S. Filipendula* (Ag.) J. Ag., but we are unwilling to refer them to that species and unwilling also, with the material at hand, to propose a new specific name in a genus in which more than two hundred more or less imperfectly understood species have already been proposed.

In the herbarium of the New York Botanical Garden (ex herb. C. L. Anderson) are four fragments of a *Sargassum* from La Paz, Baja California, which have leaves resembling those of *Vives 1* in form, size, margin, and cryptostomata, but are rather more coriaceous. One of the specimens is accompanied by a long (12 cm.) lax leafless panicle of receptacles. The panicle is detached but probably belongs with the accompanying stem and leaves.

PADINA DURVILLAEI Bory, Dict. Class. Hist. Nat. **12**: 591. 1827; Voy. Coquille, Bot. Crypt. 147. *pl. 21. f. 1.* 1828

La Paz, *Vives 5, 13*, and *15*.

No. 13 of the material communicated consists of one young specimen 5–6 cm. high and one larger, apparently mature but sterile specimen about 12 cm. high, with its main, flabellate or cuneate-flabellate lobes 10–12 cm. broad. The thallus is somewhat coriaceous and multistratose except at the extreme margin; it is for the most part 8–12 cells thick, though towards the base it may become as much as 18 cells thick. Specimens of *P. Durvillaei* in the Muséum d'Histoire Naturelle of Paris, marked "de la Concepcion, Chili, par Durville, 1825, . . . petits individus," show a thickness of 8–10 cells in median portions.

No. 5 is similar to the older plant under no. 13, but is smaller and more dissected. No. 15 consists of fragments distorted by bearing the eggs of some marine animal.

PADINA sp.

La Paz, *Vives 3*.

A much thinner and rather more calcified plant than no. 13 (*P. Durvillaei*). The single specimen gives the impression of having been semiprostrate when growing, though this appearance may be due in part to the way the specimen has been pressed and dried. The plant is 6–7 cm. long or high and its rounded-flabelliform lobes are 6–7 cm. broad. The thallus is 3 cells thick from the base to the rolled margin, which is bistratose. The surface cells are oblong, $22–68\mu \times 22–27\mu$, while in *P. Durvillaei* they are quadrate and oblong and about $13–28\mu$ in diameter. The plant represents possibly an undescribed species, but as several poorly understood species have been proposed in the genus and as our material is sterile, we would hardly venture at this time to suggest a new specific name.

Dictyota Vivesii sp. nov.

Densely cespitose, stupose at base, 7–9 cm. high, $135–160\mu$ thick (240μ at base), collapsed and thin on drying, somewhat regularly 3–6 times dichotomous below, the branches then rather closely 3 or 4 times subflabellately or subpinnately dichotomous, sinuses mostly rather acute, margins very entire or slightly un-

dulate; main segments oblong or obcuneate, 3–8 mm. broad, diminishing conspicuously in length and width in the apical subdivisions, the terminal segments mostly 1–2 mm. wide, their dichotomies forming angles of about 45°, the apices obtuse or subacute; surface on drying mostly smooth or slightly and irregularly reticulate in the older parts; cortical cells nearly uniform in size and color, $19–65\mu \times 11–27\mu$, 1–3 times longer than broad; interior cells $96–250\mu \times 55–110\mu$, very thin-walled and often inconspicuous when viewed through the cortex, the walls perpendicular to the surfaces mostly only $1–2\mu$ thick ($10–12\mu$ in basal parts), collapsing on drying; tetrasporangia forming small scattered inconspicuous sori. [PLATE 27.]

La Paz, *Vives 2* (type) and *18e*.

Dictyota Vivesii is perhaps most nearly related to *D. Bartayresiana* Lamour., but cannot well be identified with that West Indian species. It is more cespitose in habit of growth than *D. Bartayresiana*, more stupose at the base, less regularly dichotomous towards the apices, rather broader in its broadest parts and more conspicuously dwindling in width as the ultimate segments are approached, the axils (the upper at least) are more acute and the segments less patent or divaricate, the apices are less acute, and both the cortical and the interior cells are for the most part narrower and the cortical cells overlying the septa and lumina of the interior cells show scarcely any of that differentiation in form and translucency that led J. Agardh to describe *D. Bartayresiana* as "fenestrate"; the walls of the interior that are perpendicular to the surface are remarkably thin, being usually only $1–2\mu$ thick, while those of *D. Bartayresiana* are ordinarily $3–7\mu$ thick; whether wholly as a result of this thinness of the walls, or in part as a result of the treatment the specimens may have received, we do not know, but the interior cells of our dried specimens of *D. Vivesii* are so completely collapsed that they do not at all regain their natural form on being soaked with water, though they revive tolerably well on being treated with a solution of potassium hydrate. The smoothness of most parts of the surface of *D. Vivesii*, in its dried state, may be due in some measure to the presence, in many portions of the thallus, of a layer of small oval diatoms so closely adherent and so evenly disposed that their presence is revealed only by the higher powers of the microscope. The tetraspores of *Dictyota Vivesii* occasionally, as in most other species of the

genus, germinate precociously or while still attached to the thallus, so that the surface appears inconspicuously proliferous here and there.

The only Dictyotas hitherto recognized from the Pacific coast of North America are, so far as we are aware, *Dictyota crenulata* J. Ag. from St. Augustin, Mexico, and *D. Binghamiae* of California. Of these, *D. crenulata* is characterized by strong marginal teeth, which are wholly lacking in *D. Vivesii;* by elongate or lingulate, broadly obtuse or subtruncate terminal segments, which are as broad as any part of the thallus; by a cortex that is for the most part conspicuously fenestrate in the Agardhian sense; by thicker-walled cells; and by a usually reticulate surface when dry.

Dictyota Binghamiae is a coarser, thicker (275–500μ), more regularly dichotomous plant, with segments usually broader and their width better sustained towards the apices; its surface is beautifully reticulate when dry, and under the microscope the cortical cells, in most cases, show very clearly the differentiation in form and translucency that suggested the term "fenestrate" to J. Agardh. The cortex, too, of *D. Binghamiae*, towards the margins and in the older parts, often shows two or more layers of cells,—a character that is presumably responsible for its former identification with *Glossophora Kunthii*. The walls of the interior cells, that is, the walls that are perpendicular to the surface, are very firm and thick (5–30μ).

RHODOPHYCEAE

PORPHYRA LEUCOSTICTA Thuret in Le Jolis, Liste Alg. Mar. Cherbourg 100. 1863

San Felipe Bay, *D. T. MacDougal*, Feb. 1904.

This species, so far as we are aware, has hitherto been attributed, for the Pacific coast of America, only to Monterey Bay, California.* The Gulf of California specimens differ a little in color from most European and eastern American plants, tending rather more to brownish and blue-purple shades.

The thallus is about 40μ thick, surface jelly 8–11μ thick; plants monoeçious; antheridia in spots and streaks adjoining sporocarps,

* Hus, H. T. A. Zoe 5: 63. 1900; Proc. California Acad. Sci. III. 2: 202. 1902.

both unmixed with vegetative cells; carpospores 8; spermatia 64; thallus disintegrating and deliquescing when dried specimens are soaked out with fresh water.

Scinaia latifrons sp. nov.

Thallus gelatinous-membranaceous, thin, complanate, 10–16 cm. long, 4–7 times dichotomous, not constricted, the segments 5–12 mm. broad (when dry), axils rather acute and branches somewhat patent, costa obsolete, apices obtuse or shortly and bluntly apiculate: cystocarps 0.17–0.32 mm. in diameter, marginal, mostly confined to areas 1–2 mm. broad measured from the margin; carpospores irregularly ovoid or oblong, 10–22μ long. [PLATE 28 and TEXT FIGURE 1.]

La Paz, *Vives 6, 11a* (type), and *20c*.

The material submitted consists of eight specimens, all of which are amply distinct from *S. furcellata undulata*, with which it grows associated, differing in the much broader thinner flattened membranous thallus and the marginal cystocarps. Though having a pronounced "Halymenioid" habit, the plants have the peculiar and characteristic vegetative structure and cystocarps of *Scinaia*. If aberrant in any particular it is in the absence of any costa or well-defined axile strand that can be clearly recognized even in a cross section, contrasting in this respect with *S. furcellata undulata*, with which it is associated and in which a compact axile strand is very manifest in cross section at least. The thallus of *S. latifrons*, even when sections of the dried material have been treated with potassium hydrate, shows a thickness of only 80–135μ, but it is probable that fresh or liquid-preserved specimens would have a greater thickness. The thallus appears to be the thickest towards the margins, whether the margins bear cystocarps or not. A cross section of the stipe shows a compact medullary mass of filaments with a special axile strand only slightly indicated. The hyaline peripheral cells of the thallus have a height of 27–36μ, averaging considerably higher than in the associated *S. furcellata undulata*. The color of dried specimens of *Scinaia latifrons* is a light brownish rose, while that of *S. furcellata undulata* is a dingy or purplish brown.

Among the described species, varieties, and forms of *Scinaia*, *S. latifrons* is apparently most nearly allied to *S. furcellata* forma

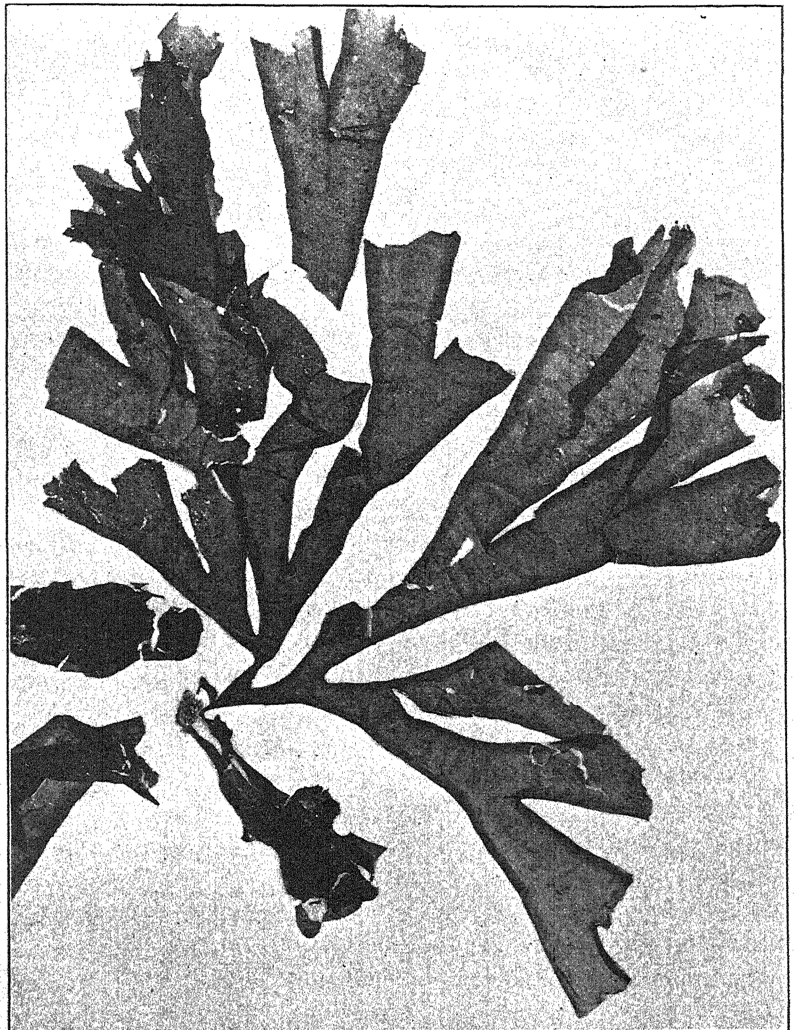

FIGURE 1. *Scinaia latifrons* M. A. Howe

(La Paz, *Vives 11a*), natural size. The dark spots showing near the margins are mostly cystocarps, but those in median parts are due to epiphytic growths. See also PLATE 28, which shows the type specimen somewhat reduced.

complanata Collins (Phyc. Bor.-Am. *836*) from Florida, but in that the segments are only 2 mm. instead of 5–12 mm. broad and the cystocarps are not confined to the margins.

SCINAIA FURCELLATA UNDULATA (Mont.) J. Ag. Sp. Gen. et Ord. Alg. 2: 422. 1852

Ginnania undulata Mont. Voy. Bonite, Bot. Crypt. 59. *pl. 145. f. 3.* 1844.

La Paz, *Vives 11d* and *20b.*

This differs from *Scinaia latifrons* as noted above.

The two specimens seen have a length of 10–14 cm. and their segments are about 2 mm. wide. The segments are probably terete or nearly so in life, though they do not regain that form on being soaked out.

The specimens appear to agree essentially with those occurring on the coast of California as far north, at least, as Santa Cruz. The peculiarities of the Pacific Coast plant seem insufficient to separate it specifically from *Scinaia furcellata.*

(?) GIGARTINA CHAMISSOI (Mert.) Mont. Voy. Bonite, Bot. Crypt. 71. 1844

San Felipe Bay, *D. T. MacDougal,* Feb. 1904.

The plants are rather small (3–8 cm. long), but are probably nearer to *G. Chamissoi* than to any other described species. The main segments are 2–10 mm. broad and are less regularly pinnate and less elongate than in *G. Chauvinii* (Bory) Mont. The narrower specimens resemble certain broader conditions of *G. Teedii* (Roth) Lamour. The faces of the segments are smooth or sometimes lightly papillate and the only cystocarps seen are marginal. The branching is much more pinnate than in any of the California specimens that we have seen referred to *G. papillata* (Ag.) J. Ag.

Anatheca dichotoma sp. nov.

Thallus cuneate-attenuate at base, subcartilaginous or somewhat gelatinous, reaching a length of 25 cm., mostly 7–11 times dichotomous and with occasional marginal proliferations, segments 6–12 mm. in greatest width, tapering to 1 or 0.5 mm. in the ultimate divisions, 0.66–1.3 mm. thick, axils rounded, branches erecto-patent, apices acuminate, almost terete or conic-terete; the

filamentous or rhizoidal medulla bordered by mostly two irregular series of large cells 240–340μ in maximum diameter in cross section, their walls rather firm, not gelatinizing much in fresh water or glycerin, remaining about 6–15μ thick, the large cells passing somewhat abruptly into the small cells of the outer cortex; the zonate sporangial tetrads irregularly ovoid, 55–85μ in long diameter; other parts not seen. [PLATE 29.]

La Paz, *Vives 7* (type), *11c*, *18b*, and *20a*.

Although our specimens are either sterile or tetrasporic, we have little hesitation in considering this plant a close relative of the one from Whidbey Island, Washington, distributed in the Phycotheca Boreali-Americana, *no. 932*, as "*Anatheca furcata* Setchell & Gardner ms." and afterwards described and figured in Univ. California Publ. Bot. 1: 310. *pl. 23. f. 39; pl. 24. f. 41.* 1903. However, we are at present unwilling to regard them as forms of one species. *Anatheca furcata* reaches a width of 2–3 cm., while *A. dichotoma* is mostly only 1–7 mm. wide; it is once to thrice forked, while *A. dichotoma* is commonly 8–10 times forked; *A. furcata* also has a darker red color, a longer, more attenuate stipe, and its cell walls are more inclined to gelatinize on being soaked out with fresh water, which fact is doubtless responsible for giving specimens a less rigid and cartilaginous habit than those of *Anatheca dichotoma*.

Gracilaria Vivesii sp. nov.

Thallus membranaceous, complanate, regularly and flabellately dichotomous (4 or 5 times forked in specimens seen), attaining a length of 14 cm., 250μ thick in younger parts, becoming 500–700μ below, broadly cuneate or inversely deltoid at base; the lower segments subquadrate or cuneate-oblong, 8–20 mm. broad below, becoming 10–35 mm. broad under the dichotomies; segments of the two ultimate dichotomies considerably narrower, oblong or somewhat linear-oblong, 7–10 mm. wide, diminishing to 4–6 mm. in the terminal; margins entire, axils rounded, dichotomies patent or occasionally somewhat divaricate, apices rounded-obtuse, color a vinous- or coralline-red fading to light greenish pink; medulla composed of two or three irregular series of subglobose, ovoid or somewhat flattened nearly empty cells 50–400μ in diameter, bounded by one or two series of much smaller subglobose or flattened subcortical cells; cortex 1–3-stratose, the surface jelly firm and 13–28μ thick: antheridia beginning as shallow pockets in the cortex, soon becoming more or less confluent and covering a large part of the

thallus surface, mostly, however, bounded by narrow reticulately disposed series of sterile cells. [PLATE 30; PLATE 33, FIGURES 1–5.]

La Paz, *Vives 20e* (type) and *11b*.

No. 20*e*, the larger of the two specimens seen, is antheridial and 11*b*, the smaller, is sterile. The plants are somewhat Rhodymenioid in habit, but their structure is rather more suggestive of that of plants of J. Agardh's subgenus *Podeum* of *Gracilaria*, though the medullary cells are more nearly empty than is customary in this group. However, the antheridia appear to harmonize much better with those of *Gracilaria*, so far as described, than with the wholly superficial or exserted and uninterruptedly expansive antheridia of *Rhodymenia*. So far as we are aware, the antheridia have been described in only three species of *Gracilaria*, viz., *G. confervoides*,* *G. armata*,† and *G. compressa*.‡

The antheridia of *Gracilaria confervoides* are described and figured as occupying nearly closed pear-shaped cavities, the bases of which penetrate the subcortical layer. Those of *G. Vivesii* are more like shallow saucers, often irregular in outline, and they are confined to the rather thin cortex and are covered only by the hyaline outer walls of what were originally epidermal cells; they seem to agree essentially with the descriptions of the antheridia in *G. armata* and *G. compressa*, and similar antheridia are present in a specimen from Barbados in the herbarium of the New York Botanical Garden, distributed as "*Gracilaria multipartita* J. Ag. fronde latiori" (Vickers, Alg. Barb. *136*).

The two nearest relatives of *Gracilaria Vivesii* are probably *G. Cunninghamii* Farl.§ (J. Ag. Sp. Alg. 3^4: 93. 1901), based upon material from Santa Barbara, California, and *Gracilaria* (?) *peruana* Picc. & Grun., from Paita, Peru. *Gracilaria Vivesii* differs from *G. Cunninghamii* in its brighter red (less brownish) color, in being regularly dichotomous instead of often somewhat tri- or polychotomous, in its less elongate, less cuneate, and broader

* Thuret, in Le Jolis, Liste Alg. Mar. Cherbourg 134. 1863; Thuret & Bornet, Études Phyc. 80–82. *pl. 40. f. 1, 2.* 1878; Buffham, Jour. Quekett Micros. Club II. 5: 294. *pl. 13. f. 11, 12.* 1893.

† Thuret, Ann. Sci. Nat. IV. 3: 22. 1855; Thuret & Bornet, loc. cit.

‡ Thuret & Bornet, loc. cit.

§ This specific name appears to have originated through the misreading of a different genitive specific name accompanying a specimen sent to Agardh by Mrs. G. A. Hall.

(20–35 mm. max. *vs.* 10–13 mm.) segments, more patent or subdivaricate branching, and larger more vacuous medullary cells. *Gracilaria* (?) *peruana* Picc. & Grun. was briefly described and thus far appears to be known only from the original collection, from which, through the courtesy of Professor G. B. De-Toni, we have been able to examine a portion of a tetrasporic specimen. *Gracilaria Vivesii* differs from it in being of a coral-red or rose instead of a sordid green or lurid brownish color, in being regularly dichotomous instead of di-polychotomous, in having segments that are subquadrate or cuneate-oblong rather than subcuneate-linear and patent or subdivaricate rather than subparallel, and in having a cortex that is 1–3 instead of 3 or 4 cells thick in the mature parts and whose outer walls are 13–28μ instead of only 4–6μ thick. The medullary cells in *G. peruana* are large and vacuous, much as in *G. Vivesii*, but are even larger, sometimes showing a maximum diameter of 650μ in a cross section of the thallus. The transition from these large medullary cells to the small cells of the cortex is a little less abrupt than in *G. Vivesii*. The thallus of *G. peruana* is rather thicker than that of *G. Vivesii*, attaining a maximum thickness of about 1 mm. in the older parts of the fragment seen; it scarcely adheres to paper.

Rhodymenia peruviana J. Ag. is doubtless deserving of mention in connection with *Gracilaria Vivesii*. The writer's present knowledge of this Peruvian species is based chiefly on Agardh's description and a photograph of the original specimen which has been accessible through the kindness of Professor O. Nordstedt. Its mode of branching and general habit do not suggest the Baja California plant, and Agardh's allusion to sori in connection with the tetrasporangia would seem to indicate that *Rhodymenia peruviana* does not belong in *Gracilaria*. In size and in habit, so far as can be judged from a photograph, *Rhodymenia peruviana* is not very different from *Gracilaria* (?) *peruana*, yet Piccone and Grunow, having before them Agardh's description of the color and consistency of *R. peruviana* and having before them also the cystocarps and scattered tetrasporangia of their own Peruvian plant, were apparently quite right both in considering their plant different from Agardh's and in referring it to the genus *Gracilaria*.

Fauchea Sefferi sp. nov.

Thallus moderately thin (30–80μ) and cartilaginous-membranaceous when dry, cartilaginous and 135–320μ thick when moist, cespitose-ascending(?), dichotomous, mostly 6–11 times forked, spreading 7–12 cm., axils rounded or subacute, segments linear, 1–2.5 mm. wide, nearly uniform in width throughout or slightly wider under the dichotomies, rarely concrescent, margins entire (except for cystocarps), the terminal segments tapering, obtuse or subacute, somewhat divaricate or patent; color a dull brownish red; medullary layer of 2–6 irregular series of large elongate nearly empty cells, these often irregularly compressed and folded, 55–137μ × 22–55μ in cross section (or reaching 240 × 110μ in basal parts), with occasional small interstitial cells, passing rather abruptly to the subcortical layer of 1–3 series of smaller thick-walled cells; cortical layer composed of distinct anticlinal rows of 4–8 series of minute cells, these 3–9μ high, walls of cortical cells soft, gelatinous, and confluent: cystocarps marginal, sessile, nearly spherical, obovoid, or hemispherical, 0.5–0.95 mm. in diameter. [PLATE 31.]

La Paz, *Vives 11e.*

Fauchea Sefferi is in a way intermediate between the Mediterranean *F. repens* (Ag.) Mont. and the Californian and possibly northern *F. laciniata* J. Ag., but is amply distinct from both. From *Fauchea repens* it differs in the evidently non-repent habit of growth, in the thin and less cartilaginous thallus, in the narrower segments (1–2.5 mm. *vs.* 2–8 mm.), in the smaller, more gelatinous-walled, more irregularly compressed and often folded cells of the medulla, in the occurrence of occasional small interstitial cells among the large cells, and in the more globose sessile cystocarps. From *Fauchea laciniata*, *F. Sefferi* differs in the dichotomous instead of palmate-laciniate mode of branching, in having the principal segments narrower (often 1 cm. or more broad in *F. laciniata*) and linear rather than cuneate, in the smaller strictly marginal and non-coronate cystocarps, in the more gelatinous cell walls, the usually more compressed cells of the medulla, etc.

The specimens, dried under pressure, adhere fairly well to paper except in the older parts.

This species is dedicated to the memory of the late Dr. Pehr Olsson-Seffer, editor of the American Review of Tropical Agriculture and professor of botany in the new Mexican University,

whose tragic and much lamented death in connection with the recent civil disturbances in Mexico occurred on April 29, 1911, a few days after he had communicated this and other Lower Californian algæ to the writer for determination.

Fauchea (?) **mollis** sp. nov.

Thallus thin (25–35μ) and membranaceous when dry, soft, lubricous, and 165–350μ thick when moist, cespitose-decumbent, flabellately subdi-trichotomous, the mats 6–9 cm. in diameter, the main segments mostly 5–8 times forked, radiating from a center and more or less overlapping in 2–4 layers, the layers here and there concrescent and coherent chiefly by deflexed more or less specialized originally marginal lobes, axils rounded and the segments again approximate or often overlapping; segments short-oblong, subquadrate, or occasionally subcuneate, 2–15 mm. broad, mostly as broad as long, margins entire, the terminal segments 2–5 mm. broad, rounded-truncate or bi-trifid-retuse; color a dull brownish red or greenish rose; medullary layer of 2 (3) series of large nearly empty cells, these mostly oval or elliptical and 82–275μ × 68–137μ in cross section, rounded-hexagonal or rounded-oblong when viewed through the cortex, without smaller interstitial cells, passing abruptly to the thin subcortical layer of 1–4 series of much smaller cells; cortical layer of mostly 2 series of minute cells 5–9μ high, anticlinal filaments scarcely recognizable unless at margins, walls of cortical cells soft, gelatinous, confluent, and hardly visible when soaked out, other parts wanting. [PLATE 32; PLATE 33, FIGURE 6.]

La Paz, *Vives 18a* (type) and *11f*.

The specimens described above are apparently sterile, but in habit and vegetative structure they have so much in common with *Fauchea* that we can feel little doubt as to their generic affinities. *Fauchea (?) mollis* is perhaps most nearly allied to the Australian *F. nitophylloides*,* but the segments of the Baja California plant are short-oblong or subquadrate instead of linear, the thallus is much thicker (165–250μ *vs.* 65–85μ) and much more gelatinous, so that it adheres very firmly to paper, the medullary cells are much larger (82–275μ *vs.* 27–68μ, long diameter in cross section) the walls of the cortical cells are gelatinous and confluent when soaked out instead of firm and distinct, and the color is a dull brownish red or greenish pink instead of scarlet.

* For the privilege of examining authentic material of this species we are indebted to Professor W. G. Farlow and Mr. F. S. Collins.

J. Agardh has remarked that in habit *Fauchea nitophylloides* suggests *Rhodophyllis bifida* or narrow specimens of *Nitophyllum ocellatum*. It may be said that *F.* (?) *mollis* suggests the broader conditions of these species. In strucıure *F.* (?) *mollis* is not very different from certain species of *Gracilaria* of J. Agardh's subgenus *Podeum*, section *Rhodymenioideae*, but the cell walls and the frond as a whole are softer and more gelatinous than in any *Gracilaria* that we are familiar with and the large cells of the medulla are more hyaline and vacuous than is customary in that section of *Gracilaria*.

LAURENCIA PANICULATA (Ag.) J. Ag. Sp. Gen. et Ord. Alg. 2: 755. 1852

Chondria obtusa paniculata Ag. Sp. Alg. 343. 1822.

La Paz, *Vives 22*.

Plants rather more slender and ultimate branchlets more elongate than in specimens from La Jolla, California, distributed in Phyc. Bor.-Am., *no. 1093*.

The current name for the species is used here provisionally, though the specific name appears to depend for its priority on its publication as a varietal name, which violates all of the current codes of nomenclature. Two older names in the specific category that are commonly cited as synomyms are *Laurencia patentiramea* (Mont.) Kütz. and *L. glandulifera* Kütz., but the older of these, *L. patentiramea*, according to Montagne's original figure, does not apply very accurately to our Baja California plant and there are possibly grounds for doubting the alleged synonymy. The elongate ultimate branchlets of the Vives plant are rather suggestive of those figured by Kützing (Tab. Phyc. 15: *pl. 63. f. a, b*. 1863) for his *L. paniculata*, but they are not distichous or pinnate. Kützing's *Laurencia paniculata*, which, by the way, antedates J. Agardh's, is referred to *L. pinnatifida* by De-Toni; J. Agardh first cited it as a doubtful synonym under his own *L. paniculata*, but afterward (op. cit. 3: 651) omitted to refer to it.

POLYSIPHONIA CALIFORNICA Harv. Ner. Bor.-Am. 2: 48. 1853

San Felipe Bay, *D. T. MacDougal*, Feb. 1904.

The specimens are a little more luxuriant than Harvey's type

from "Golden Gate, California," but they agree closely in habit, color, and structure.

The pericentral siphons are usually ten in number but vary from nine to eleven. The basal internodes are 6–10 times as long as wide. Simple colorless monosiphonous "leaves" are abundant at the tips.

CENTROCERAS CLAVULATUM (Ag.) Mont. in Durieu, Fl. Algérie 1: 140. 1846

Ceramium clavulatum Ag. in Kunth, Syn. Pl. Aeq. 1: 2. 1822.

La Paz, in the herbarium of the New York Botanical Garden, ex herb. C. L. Anderson, collector unknown.

The fragmentary specimen is from a stouter and more spiny plant than the original *Ceramium clavulatum* Ag., which was brought from Callao, Peru, by Humboldt. It also has shorter internodes and more forcipate apices. It suggests Kützing's figures of his *Centroceras oxyacanthum*, drawn from a South African specimen, though originally described from Cuban material; however, the spines are less conspicuous than in *C. oxyacanthum* and are not much in evidence, except at the apices.

The type of *C. clavulatum* in herb. Agardh is a slender plant with rather strict dichotomies, the tuft standing about 3.5 cm. high. The filaments are 85–110μ in diameter; the internodes are 320–510μ long below, becoming about 80–100μ long under the terminal dichotomy; the apices are incurved only in the youngest growth stages and are scarcely forcipate in the usual sense of the term; no lateral innovations were noticed; the spines are few, small, erect or incurved, and very inconspicuous, consisting of one or two cells and rarely reaching a length of 40μ. Kützing was doubtless right in suspecting* that the original *Ceramium clavulatum* belonged with his own *Centroceras cryptacanthum*, of which his var. *β. longiarticulatum* came from the coast of Peru, the type region of *Ceramium clavulatum* Ag.

Halymenia actinophysa sp. nov.

Thallus plane, sessile (?), very thin (70–130μ), gelatinous-membranous, elliptic-obovate or irregularly orbicular, attaining a length of 30 cm. or more and width of 20 cm., occasionally and

* Linnaea **15**: 742, 743. 1841.

irregularly perforate, the margins entire or sinuate or here and there irregularly dentate or lacerate, the surface nitent, the color mostly a light greenish rose; medullary filaments sparingly laterally or subdichotomously branched, 14–24μ in diameter, gradually enlarging distally (often becoming 27–40μ in older parts) and each terminated by a subglobose capituliform cell, this 45–95μ in diameter and emitting radially or stellately 3–14 (usually 6 or 7) rather straight and rigid branches, these connecting with one or two series of similar or more flattened radiately branched and reticulately joined subcortical cells, succeeded by one or two series of smaller subglobose or flattened anastomosing subcortical cells and the monostromatic or occasionally distromatic cortex; the cortical cells subglobose, obovoid, or more often flattened in the plane of the surface, 5–13μ in diameter, usually 3–6 from each subjacent cell: other parts unknown. [PLATE 34.]

La Paz, *Vives 20d.*

The three specimens on which the foregoing description is based are evidently fragments and some of the details of the diagnosis, especially as regards the size and form of the thallus, may require modification when more material is available. The specimens, also, appear to be sterile, but their structural characters are such that we feel little hesitation in referring them to the *Hymenopsis* section of *Halymenia*—the section that includes the European and Mediterranean *Halymenia latifolia* Crouan and *H. ulvoidea* Zanard., and possibly also the American *H. floridana* J. Ag. *Halymenia latifolia* has a firmer, relatively narrower, less nitent thallus of more definite regular form and a well-defined cuneate stipe; it is not certain that the holdfast is present in any of the Baja California fragments, but what appears to be a subtruncate or slightly cordate base in one of them suggests that the plant is sessile. *H. latifolia* has radially branched cells in the subcortex that sometimes resemble the smaller of the radiate or stellate subcortical cells of *H. actinophysa*, but they are (in a Brest specimen) only 25–30μ in diameter, have usually but 3–5 branches, and are nearly always much flattened; if these radiate cells in *H. latifolia* often in form suggest Asteroid or Ophiuroid "star-fishes," the corresponding cells in *H. actinophysa* in a detached condition may remind one of the pollen grains of certain Malvaceae or the "morning-star" maces of the 15th century.

The limits of *Halymenia floridana* J. Ag. are imperfectly under-

stood and it is probable that the name has been applied to more than one thing, but, in any event, it has, as a rule, a considerably thicker, less gelatinous thallus than *H. actinophysa*, and is less nitent when dry. In a cystocarpic specimen from Florida in herb. Agardh, communicated by Mrs. Floretta C. Curtiss, the medullary filaments are 8–13μ in diameter and have dense granular contents, the subcortical layer consists of 1–3 series of ovoid or subglobose densely granular cells, mostly somewhat flattened in the plane of the thallus; conspicuously capitate endings for the medullary filaments are scarcely found, though the subcortical cells anastomose and are sometimes inconspicuously 3–6-radiate; it should be said, however, that there are frequent large ganglioid or irregularly stellate cells or filaments which have more homogeneous contents, and whose branches make their way freely among the ordinary vegetative filaments; these we take to be the sporogenous filaments. But in thicker, more gelatinous plants that have been referred to *H. floridana*, with more vacuous, more flexuous, and commonly a little larger medullary filaments (such, for example, as Phyc. Bor.-Am. *749a*, *b*, and *c*), one often finds stellate vegetative ganglia in the medulla and finds also the medullary filaments terminating in the subcortex in a subglobose radiately branched cell, but this rarely exceeds 30μ in diameter and its branches very rarely, if ever, exceed six in number.

Of *Halymenia ulvoidea* Zan. and *H. coccinea* Ardiss. we have been able to examine no authentic specimens, but *H. ulvoidea* is described and figured as having a dentate-ciliate margin and *H. coccinea*, which De-Toni hints may be *Callymenia Requienii*, is said to have a lamina only 1–2 cm. wide.

Halymenia actinophysa is in some respects rather suggestive of *Aeodes nitidissima* J. Ag., an apparently original cystocarpic specimen of which, collected by Berggren at Tauranga, New Zealand, and sent out by J. Agardh, we have been able to examine through the courtesy of Professor Farlow. But *H. actinophysa* is a thinner, softer, more gelatinous plant (the thallus of *Aeodes nitidissima* is about 240μ thick) and is quite different in vegetative structure. In *Aeodes nitidissima* the medullary filaments on reaching the subcortex send out usually 3 branches in a somewhat verticillate manner, but there is very rarely any tendency to a capitate enlarge-

ment, in fact, the diameter of the filament commonly suffers a slight diminution at the nodal point; the cells of the subcortex have substellate anastomosing branches, but the cells are very small in comparison with the corresponding cells of *Halymenia actinophysa* and they rarely have more than 3 or 4 branches. The cortex of the New Zealand *Aeodes nitidissima* consists of distinctly anticlinal moniliform filaments of which the ultimate peripheral cells are, as described by Agardh, decidedly narrower than the subjacent cells ("exterioribus conspicue angustatis"); these cells are only 1–3μ in diameter when viewed from the surface, but in a cross section of the thallus are seen to be about twice as high as broad. It may be remarked that in the specimens from Whidbey Island, Washington, distributed in the Phycotheca Boreali-Americana (*no. 946*) as *Aeodes nitidissima* J. Ag., the cells of the cortex may hardly be described as being in distinct anticlinal rows, and the ultimate peripheral cells instead of being conspicuously narrower than those immediately subjacent are of equal width or even broader and have 2–4 times the diameter of the corresponding cells in the New Zealand plant.

The dried specimens of *Halymenia actinophysa* adhere very firmly and intimately to paper. The cell walls are so gelatinous and translucent that one gets little idea of the real structure of the thallus by examining an ordinary section in water or in water and glycerin—at least until one has learned otherwise what to expect and look for; but by staining sections or fragments with haematoxylin and afterwards swelling out the more or less collapsed cells by applying a little potassium hydrate or picric acid, the relations of the parts become manifest.

NEW YORK BOTANICAL GARDEN.

Explanation of plates 27-34

PLATE 27. *Dictyota Vivesii*

A photograph of a portion of the type specimen (La Paz, *Vives 2*), natural size. The stipe is shown towards the lower right-hand corner.

PLATE 28. *Scinaia latifrons*

A photograph of a portion of the type specimen (La Paz, *Vives 11a*), nine tenths of the natural size. The cystocarps are visible near the margins in the median portions. See also FIGURE 1 (in text), which shows a better mounted, though mutilated specimen.

PLATE 29. *Anatheca dichotoma*

A photograph of a portion of the type specimen (La Paz, *Vives 7*), a little more than one third of the natural size.

PLATE 30. *Gracilaria Vivesii*

A photograph of a portion of the type specimen (La Paz, *Vives 20e*), about four fifths of the natural size.

PLATE 31. *Fauchea Sefferi*

A photograph of portions of the type specimen (La Paz, *Vives 11e*), natural size, showing marginal cystocarps, etc.

PLATE 32. *Fauchea (?) mollis*

A photograph of portions of the type specimen (La Paz, *Vives 18a*), natural size.

PLATE 33

1-5. *Gracilaria Vivesii*

1. A cross section of the thallus of an antheridial plant.

2. Surface of antheridial plant. The figure was drawn from a fragment soaked out in water and mounted in glycerin, in which medium the boundaries of the gelatinous walls of the vegetative cells cannot be seen with sufficient distinctness to be drawn accurately. In this mature condition of the antheridia, the gelatinous outer wall shown in FIG. 3 as covering the antheridium has mostly dissolved away and the spermatia occupy shallow cavities in the cortex.

3. A vertical section through an antheridium, which appears to arise through the transformation of the two outer layers of cortical cells.

4, 5. Young antheridia and adjacent vegetative cells in surface view.

FIGURE 1 is enlarged 57 diameters; 2–5, 345 diameters; all from the type specimen (*Vives 20e*).

6. *Fauchea (?) mollis*

A cross section through the thallus, enlarged 57 diameters.

7. *Cladophora MacDougalii*

An apical portion of one filament and a fragment near the apex of another, enlarged 11 diameters.

PLATE 34. *Halymenia actinophysa*

1. A cross section of the thallus, partially diagrammatic. The figure was drawn from dried material soaked out in water and mounted in glycerin, under which treatment the outlines of the various structural elements, particularly of the large cells of the subcortex, are less distinctly visible than indicated in the figure. The larger cells are often so flattened, collapsed, or translucent that the medulla commonly appears relatively broader and the cortex thinner than represented; and the medulla is often less compact.

2. A fragment from the cortex and subcortex, showing anastomoses of the subcortical cells, etc.

3. Another fragment, showing other forms of cortical cells and their relations to the subcortex.

4. Cortical cells in surface view; from a glycerin mount, in which the boun daries of the cell walls are too indistinct to be drawn with accuracy.

5. A similar view in an older part of the thallus, with the cell walls more swollen and the protoplasts more widely separated.

6. Cortical cells in surface view, after staining with haematoxylin and treatment with KOH. The grouping of the cells indicates more or less clearly their relations to the subcortical cells; e. g., the upper group of six cells crowns a single subcortical cell.

7. A stellate or radiate termination of one of the medullary filaments.

8, 9. Capitate and stellately branched terminations of the medullary filaments in more detail. The pedicel in each figure shows the beginning of a lateral branch.

10. Cells of the subcortex, showing connections and mode of branching.

11. A somewhat flattened branched cell of a form that occurs in the subcortex about halfway between the cortex and the capitate terminations of the medullary filaments.

12. A portion of a medullary filament terminating in the subcortex and showing the beginnings of two lateral branches. The terminal cell of such branches carries a dense and conspicuous protoplast.

13. Stellately branched subcortical cells from a young part of the thallus, one of them showing 13 branches. These branches connect with other similar, but mostly smaller and more peripheral cells, from which they have been detached.

FIGURES 1–6, 8, 9, 11, and 12 are enlarged 276 diameters; 7 and 10, 46 diameters; 13, 244 diameters. The sections and fragments from which figures 2, 3, 6, 7–10, 12, and 13 were drawn were stained with haematoxylin and then swollen out with a solution of KOH; in figures 2, 3, 8, and 9, the thickness of the gelatinous cell walls and probably the dimensions of the parts in general have been somewhat exaggerated by an excess of KOH. FIGURE 11 was drawn from material that had been stained with picric-nigrosin.

The relation of climax vegetation to islands and peninsulas

Roland M. Harper

Lake Tsala Apopka, in the eastern part of Citrus County, Florida, is a shallow irregularly shaped sheet of water about 15 miles long and 5 miles wide, lying parallel to the Withlacooche River, just about on the line between the lime-sink and Gulf hammock regions.* Its bed and shores, like most of the surface of central Florida, are composed of sand presumably many feet in depth, covered with a little humus or peat in certain spots, but mostly fully exposed to the light. The topography in that part of the state is determined not so much by subaerial erosion as by irregular solution of the limestone which underlies the sand, and undulates in such a way as to give the lake an extremely sinuous outline.† This lake is so interspersed with islands and peninsulas that there is probably no point on its shores from which more than a few hundred acres of water can be seen at one time, even at its highest stage.

The country bordering the lake, on the west side (I have never been on the east side) is of the type known in Florida as "high pine land"; which means that it is covered with open forests of long-leaf pine, *Pinus palustris* (which is probably more abundant in central Florida than all other trees combined), with a fairly dense undergrowth of grasses and other herbs—most of them with small or narrow leaves—almost no shrubs or vines, and no mosses or lichens on the trees. Probably the most striking difference between long-leaf pine forests and other kinds is the scarcity of shade, and the other differences are in large measure correlated with this.

On January 21, 1909, when Lake Tsala Apopka was so low that one could make many short-cuts across its embayments (as is usually the case with Florida lakes in winter), I walked past or

* See Ann. Rep. Fla. Geol. Surv. 3: 221, 222. *pl. 16.* 1911.

† This peculiar topography is brought out very plainly on the Tsala Apopka topographic sheet of the U. S. Geological Survey (surveyed in 1893 and published in 1895, on a scale of about an inch to the mile).

across several of the peninsulas above mentioned, a few miles northeast of Inverness, and was much interested to find them all covered with rather dense forests of the "hammock"* type, contrasting strongly with the neighboring pine forests. As compared with the high pine land, equal areas on the peninsulas had trees much more numerous and herbs scarcer, both in individuals and species, and the trees all had broad leaves, giving a fairly dense shade. The composition of the peninsula forests, as determined by a few hours of rather hasty observation, seemed to be approximately as follows. (Trees, shrubs, and herbs are separated, and the species of each arranged as nearly as possible in order of abundance. Evergreens are indicated by bold-face type.)

TREES

Persea Borbonia
Magnolia grandiflora
Cornus florida
Osmanthus americana
Hicoria sp.
Quercus laurifolia
Quercus virginiana
Quercus geminata
Quercus Chapmani
Liquidambar Styraciflua
Ilex opaca

SHRUBS AND WOODY VINES

Batodendron arboreum
Cholisma ferruginea
Serenoa serrulata
Vitis rotundifolia
Gelsemium sempervirens
Phoradendron flavescens
Myrica cerifera
Aralia spinosa

HERBS

Tillandsia usneoides
Polypodium polypodioides
Epidendrum conopseum
Smilax pumila
Tillandsia tenuifolia?
Opuntia vulgaris
Mitchella repens
Rynchospora dodecandra

LICHENS

Trypethelium cruentum?

It is worth noting that in this list all but four of the trees,

* For definition of this term see Science II. 22: 400–402. 29 S 1905; Ann. Rep. Fla. Geol. Surv. 3: 98, 217. 1911.

all but two of the shrubs, and all the herbs, are evergreen; that two of the shrubs are vines, and half the herbs are epiphytes. It happens that all the herbs listed, except the last, have perennial stems above the ground; but a visit in summer would probably reveal a few herbs of the ordinary type, whose aerial parts die down in winter.

The broad leaves and consequent shade, the preponderance of woody plants over herbs, the absence of conifers, and the presence of several vines and epiphytes, are all characters of climax vegetation; but in the large proportion of evergreens, and a few other particulars, these hammocks differ considerably from the "mesophytic climax" forests a few hundred miles farther inland, where the soils are more clayey and the winters colder and wetter than in peninsular Florida. Forests very similar in aspect and composition to those just described, however, are found in many other parts of the coastal plain where deep sandy soils, mild dry winters and wet summers prevail, and they probably represent the climax type for those conditions of soil and climate. Although none of the species above listed are peculiar to Florida, about half of them are confined to the coastal plain or very nearly so.

The only apparent difference between the soil of the hammocks and that of the neighboring pine land was that due to the vegetation itself, namely, a small amount of humus (which is necessarily present in all hammocks and other shady upland forests) on the peninsulas. There is no reason to believe that the underlying limestone is any nearer to the surface on the peninsulas than elsewhere, and few of the plants listed are supposed to have any particular fondness for lime. Although I did not set foot on any of the islands in the same lake, I have no doubt that their vegetation differs little from that of the peninsulas.

Afterwards I observed a similar state of affairs at many other places in Florida, particularly in the lake region,* where many of the larger lakes have one or more narrow or narrow-necked peninsulas projecting out into them, with vegetation apparently always of the hammock type—if not already destroyed and replaced by orange groves or some other form of agricultural enterprise. And wherever islands occur in these lakes the vegetation

* See Ann. Rep. Fla. Geol. Surv. 3: 223. 1911.

seemed to be even denser if anything than on the peninsulas; which is just about what one would expect, whatever the cause of the approach to climax conditions on the peninsulas. From examining maps and literature, and from my own field notes for other parts of the country, I have been led to the conclusion that this relation between climax vegetation (the term "hammock" is not used so much outside of Florida) and peninsulas or islands is almost universal, at least in the coastal plain, and where the width of the peninsulas or islands lies between certain limits. A few examples in the coastal plain, from New Jersey southward, will serve to illustrate this principle.

Cape May, New Jersey, and neighboring beaches, from all accounts, are or have been noted for their fine white oaks, hollies, cedars, and some other trees which are rare or absent in the pine barrens a few miles farther north.*

On the Delaware peninsula, especially in Virginia, where it is narrowest, there are quite a number of species of trees and shrubs that are characteristic of hammocks farther south.† The whole coastal plain of Virginia north of the James River is cut up into peninsulas, and lacks many of the pine-barren plants which are found both in New Jersey and in North Carolina.‡ The original forests of this region (northern "Tidewater Virginia") must have been mostly hardwoods,§ and the timber and the accompanying humus-laden soil were doubtless among the attractions that determined the location there of some of the earliest English settlements in America, in the seventeenth century.

* See Ann. Rep. State Geol. N. J. 1891: 134–136; 1894: 262, 263; 1899 (Forests): 251, 252.

† See Torreya 9: 223. 1909. *Tillandsia usneoides*, a characteristic epiphyte of the Florida hammocks, has been reported from this same peninsula by Mr. Robert Ridgway (Bull. Torrey Club 8: 6. 1881), a fact that has been overlooked by many subsequent writers.

‡ See Torreya 7: 44. 45. 1907; 9: 217. 1909. Dr. Forrest Shreve, in his recent Plant Life of Maryland (pp. 85–88), has commented on the absence of some of the same species from the coastal plain of that state, which is also extensively dissected into peninsulas. Some notes on insular and peninsular vegetation on the western shores of Chesapeake Bay, by Dr. M. A. Chrysler, can be found on pages 187–189 of the same volume. According to C. D. Mell (Md. Geol. Surv., report on St. Mary's Co., p. 183, 1907) hardwoods originally predominated in this part of Maryland.

§ See Bull. Torrey Club 37: 422, 423. 1910.

The forests on the narrow sandy islands or "banks" which fringe the coast of North Carolina are said to consist almost entirely of angiospermous evergreens, including a large proportion of the same species already mentioned as growing in Florida.* Very few islands in the coastal plain north of South Carolina seem to have any pines on them.

The coast region of South Carolina, Georgia, and northeastern Florida, between the Santee and St. Johns rivers, is bordered by innumerable sandy islands, of diverse sizes and shapes, separated from each other and from the mainland by salt marshes and an intricate network of tidal channels; and these islands, or rather the portions of them not occupied by dunes and marshes, are wooded mostly with *Quercus virginiana* and its usual associates, pines being scarce or entirely absent on many of them.†

Paradise Key or Royal Palm Hammock, at the south end of the Everglades of Florida, is an island at high water, and is noted for its dense growth of tropical hardwoods, a few of which are not known to be arborescent anywhere else in the United States. Long Key, about half a mile away, is covered mostly with open pine forests, but at its eastern end, next to the channel which drains that end of the Everglades, there is a strip of hammock.‡

Among the Florida Keys proper, which are true islands, surrounded by salt water, pines are found only on a few of the largest ones,§ and the same seems to be true of the Bahamas, from all accounts. In both groups the smaller islands, except those small and low enough to be washed over by the waves, are as a rule covered with dense evergreen hammocks. In these Bahama and south Florida localities the soil is Pleistocene limestone instead of sand, and the pine is not *Pinus palustris* but *P. caribaea;*

* See Kerr, Tenth Census U. S. **6**: 545, 561, 562, 564. 1884; Ashe, Bull. N. C. Geol. Surv. **6**: 145–147. 1898; Kearney, Contr. U. S. Nat. Herb. **5**: 271, 272. 1900.

† For a description of the vegetation of one of these islands on the coast of South Carolina see Coker, Torreya **5**: 135–145. 1905.

‡ See Britton, Jour. N. Y. Bot. Gard. **5**: 130–132. Jl 1904; Small, ibid. **5**: 157–164. Au 1904; **8**: 24. F 1907; **10**: 49–54. Mr 1909; Harper, Fla. Review **4**: 149, 152. Au 1910.

§ See Curtiss, Gard. & For. **1**: 279, 280. 1888; Small, Jour. N. Y. Bot. Gard. **12**: 153–157. 1911; also Ann. Rep. Fla. Geol. Surv. **3**: 229. 1911.

but that is pretty closely related to *P. palustris* and very similar in its habits.*

On the Gulf coast of peninsular Florida, islands are rather scarce; but the coast of west Florida, Alabama, and Mississippi† is very similar in topography and vegetation to that of North Carolina, already referred to. Dr. Hilgard has described some sandy peninsular hammocks on the coast of Mississippi, differing from true peninsulas only in that the open water bordering them is partly replaced by marsh; and their vegetation, from his account,‡ is very similar to that already described.

Besides the peninsulas on the shores of lakes and oceans, there is another very common class, of worldwide distribution, formed by creeks and rivers. River peninsulas may be either at the confluence of two tributaries, or in "ox-bows" formed by meandering (and either kind may develop further into islands). Almost every one, in the southeastern United States at least, has noticed that such peninsulas, even above the reach of overflow, usually seem to have the richest soil in the neighborhood, and if not already cleared and cultivated, they are likely to bear some fine hardwood timber. This feature is of course more conspicuous in the long-leaf pine regions of the coastal plain, where the forests away from the streams are essentially of a pioneer type, than it is in the hardwood regions farther inland, where the contrast can never be so great.

Similar instances might be multiplied indefinitely;§ but the foregoing will probably suffice to show the universality of this relation between climax vegetation and small land areas wholly or partly surrounded by water or marshes, in our coastal plain. Almost the only exceptions to the rule seem to be those islands and beaches

* *Pinus caribaea* has been confused by recent writers on North American trees with *P. Elliottii*, a common and characteristic species of pine-barren ponds, branch swamps, etc., from South Carolina to Central Florida and Mississippi. They are not easily distinguished in the herbarium, but their ranges and habitats are quite different, *P. caribaea* being semitropical, and having about as little use for water as *P. palustris* has.

† For a description of the vegetation of some of the islands of Mississippi see Lloyd & Tracy, Bull. Torrey Club **28**: 61–101. *pl. 8–11*. 1901.

‡ Geol. and Agric. Miss. 383, 384. 1860.

§ The reader who is sufficiently interested to follow up the matter can find descriptions of many peninsular hammocks in Bartram's Travels and other works of similar nature.

which are so narrow and so far from the mainland that they have no area sufficiently protected from the winds to allow humus to accumulate and hardwood forests to develop, or are so low that they are swept by the waves. Such beaches are found along the south shore of Long Island, on the coast of North Carolina, in the east and west Florida coast regions,* along the coast of Mississippi, and in various other places.

Now for the explanation of the phenomenon above described. Of the several hypotheses which readily suggest themselves, the least probable will be taken up and disposed of first.

In the case of islands and peninsulas bordered by large bodies of water (either fresh or salt), particularly some of the northernmost ones here discussed, it has been supposed by some that the peculiarities of their vegetation, and their agricultural advantages, are due to the temperature being kept more uniform by the proximity of the water, and especially to the greater exemption from frost enjoyed by such places. But the climax plants, or many of them at least, are not known or believed to be any more sensitive to heat and cold than the pioneer plants of the same regions are. In fact nearly all the hammock plants of central Florida are perfectly at home several hundred miles farther north,† and remote from large bodies of water. Furthermore, the temperature hypothesis would hardly explain the marked contrast between the peninsular hammocks of the Florida lakes and the pine forests which border the more gently curving shores of the same lakes; or the stream-fork peninsulas, where the width of the streams is often insignificant.

It might also be claimed that the islands and peninsulas are better watered than the pine forests near by; but this is not always true, and besides, the hammock plants are not especially moisture-loving, decidedly less so, for example, than bog plants, which are mostly of the pioneer class.

It might be true in some cases, such as on the sea islands and stream-fork peninsulas, that there is some fundamental difference in the soil. But in many or most of the instances cited, whatever difference there is in the soil can be ascribed to the vegetation

* See Ann. Rep. Fla. Geol. Surv. 3: 218, 226. 1911.

† This statement does not apply, however, to the hammock vegetation of south Florida and the Bahamas, mentioned incidentally above.

itself. Not only is shade conducive to the accumulation of humus and the retention of moisture, but the shade, humus, and moisture together favor the development of bacteria, fungi, worms, insects, and numerous other inconspicuous organisms, both animal and vegetable, which work on the soil in such a way as to increase the available nitrogen and otherwise improve it.* This, in short, is the regular way in which biotic succession (as defined by Cowles,† and distinguished from regional and topographic succession) proceeds, the world over.

For the Florida hammock peninsulas, if not for all the other cases referred to, the key to the situation can be expressed in a single word: FIRE. All the long-leaf pine forests of which I have any knowledge (and I have seen them in seven of the nine states and about 200 out of some 300 counties in which *Pinus palustris* is found), even the more or less isolated ones in the mountains of Georgia and Alabama, bear the marks of frequent fires. In prehistoric times these fires were doubtless set by natural agencies, probably mostly lightning, and each spot perhaps did not get burned over oftener than once in several years, on the average. Although fires may not be started by lightning on any one square mile oftener than once in several decades, a fire once started in the grassy carpet of an unbroken pine forest might easily spread over several square miles, so that every acre of such forest if not protected in some way would be likely to be burned over every few years. Forest fires are now usually set by man,‡ sometimes purposely and sometimes accidentally, but the increase in number of fires due to this cause has been partly counterbalanced by the numerous highways, clearings, etc., which serve as barriers to fire, so that the frequency of fire at any one point in the pine barrens may not be over two or three times as great as it was in prehistoric times, and the geographical distribution of forest fires in the southeastern states has probably not been changed materially.

* See in this connection a paper by J. W. Harshberger in Science II. **33**: 741–744. 12 My 1911.

† Bot. Gaz. **51**: 171–181. 1911.

‡ The Indians are supposed to have burned the pine woods for centuries before the white man arrived, and done it more regularly, but the differentiation between pine barrens and insular and peninsular hammocks probably antedates the whole human race.

It is pretty well known that long-leaf pine, after it is four or five years old, is less affected by fire than almost any other tree we have,* and in southern forests periodically swept by fire little else can grow but this pine and a great variety of more or less xerophytic, mostly perennial, herbs, among which various grasses are usually most abundant.

An island would ordinarily be exempt from fires except such as might originate on it, and consequently the smaller the island the less the chances of fire. On a peninsula, whether bordered by open water, marshes, or narrow streams, fire could approach from only one direction, and there would be many chances of its being stopped by rain, fallen logs, etc., before going very far down the peninsula, so that the frequency of fire in such places would be very much less than in unprotected forests where fire could approach from any direction.

On this theory it is easy to account for the origin of insular and peninsular hammocks. About half the species of plants listed above have fleshy fruits, and are presumably disseminated mostly by birds; and several others have nuts which may be carried considerable distances by rodents, such as squirrels. The seeds of such plants are doubtless being dropped all through the fruiting season in all sorts of places, and occasionally one will germinate, if it falls in the right kind of soil and does not encounter enemies or too much competition. In this way an island or peninsula which we might suppose for the sake of argument to have been originally covered with pine-barren vegetation would gradually become seeded with hardwoods.† The absence of fire would in time allow sufficient humus from the pioneer vegetation to accumulate to give the hardwoods a start, and the latter would grow up and finally make enough shade to prevent the reproduction of the pines and other pioneer plants, which are what foresters term intolerant, and will not germinate in dense shade.‡

* This point is discussed on pages 71–87 of a little book by G. Frederick Schwarz, entitled "The long-leaf pine in virgin forest," published in 1907.

† The ratio of fleshy-fruited trees to oaks and hickories should be somewhat greater on islands than on peninsulas, on account of the greater accessibility of the latter to mammals, but I have not yet investigated enough islands quantitatively to say whether this is true or not.

‡ In this connection Professor Bray's observations on the growth of *Pinus palustris* in eastern Texas (U. S. Bureau of Forestry Bull. 47: 22, 23. 1904) are of interest.

The relation between fire exemption and climax vegetation is reciprocal, for when the hardwoods are once well established the herbaceous vegetation under them is very sparse, and the humus is usually too damp or too thoroughly decomposed to burn readily. (There are of course all gradations between pioneer and climax forests, but I refer now to the extremes, and not to such intermediate stages as the common deciduous oak-hickory forests of the East and South, in which burning of the dead leaves in the fall, mainly through human agency, is a rather frequent occurrence.)

Outside of the long-leaf pine region or southern pine barrens (and south of the great northern coniferous forests, where fires are much more spectacular, and present a different set of problems) forest fires from natural causes, although they still occur, are less frequent, and the contrast between open and protected forests is consequently less marked. Peninsulas as wide as those of "Tidewater Virginia" would probably offer little hindrance to fire if their vegetation were of the pine-barren type, but they are just outside of the range of *Pinus rigida* on the one hand and *Pinus palustris* on the other, and the various hardwoods and short-leaf pines which prevail there* grow densely enough to make fires rather rare.

Although it is a little beyond the scope of this paper as indicated by the title, there is another piece of evidence in favor of the fire-protection theory of climax vegetation in the coastal plain that ought to be mentioned here. This theory furnishes a satisfactory explanation of another class of hammocks which has never been fully explained before: namely, those of the Altamaha Grit region of Georgia.† These are invariably located along creeks or rivers, and nearly always on the sandhill side of the stream. Their vegetation is very similar to that described above for the peninsulas of Lake Tsala Apopka. In former years I sought for the cause of these hammocks in the subsoil or the ground water; but it is clear now that protection from fire is the principal cause. For the pine-barren side of a stream, with its close carpet of wiregrass and

* See Bull. Torrey Club 37: 422, 423. 1910. The differences in vegetation on opposite sides of Hampton Roads are now a little easier to explain than they were before.

† See Ann. N. Y. Acad. Sci. 17: 98–102. *pl. 16.* 1906.

other inflammable herbs, is not usually sufficiently protected from fire to allow hammock vegetation to obtain a foothold there, while the sandhills, whose vegetation is so sparse that fires on them are very rare, furnish an excellent protection on that side. The trees in the swamp at the base of nearly every stream sandhill probably furnish the humus to start with, and the birds and squirrels bring the berries and nuts of the hammock plants, which gradually spread up the bare sandy slopes, making their own humus as they go.

The same theory also seems to explain why pine barrens approach nearer to salt marshes and salt water in Mississippi than in Georgia; a fact which I commented upon a few years ago* but could not account for at the time. The country within a few dozen miles of the coast in Georgia is considerably lower and flatter than that similarly situated in Mississippi, and tidal estuaries have encroached on it to a much greater extent, making many islands and narrow-necked peninsulas, as pointed out on a preceding page. In Mississippi the pine flatwoods are sparingly represented if at all, and undulating pine barrens like those of the Altamaha Grit region of Georgia come right down to the coast, the typical branch-swamp vegetation occurring within a few hundred yards of Mississippi Sound at Gulfport and elsewhere.

The shell hammocks on the coast of Alabama and Mississippi, described by Mohr † and Hilgard, ‡ must owe the peculiarities of their vegetation at least in part to the protection from fire afforded by the marshes or waterways by which they are invariably bordered.

GEOLOGICAL SURVEY OF ALABAMA.

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* Torreya 6: 201, 203. 1906.

† Contr. U. S. Nat. Herb. 6: 133. 1901.

‡ Geol. & Agric. Miss. 373, 374, 380. 1860; Tenth Census U. S. 6: 270, 271. 1884; Soils 495, 497. 1906.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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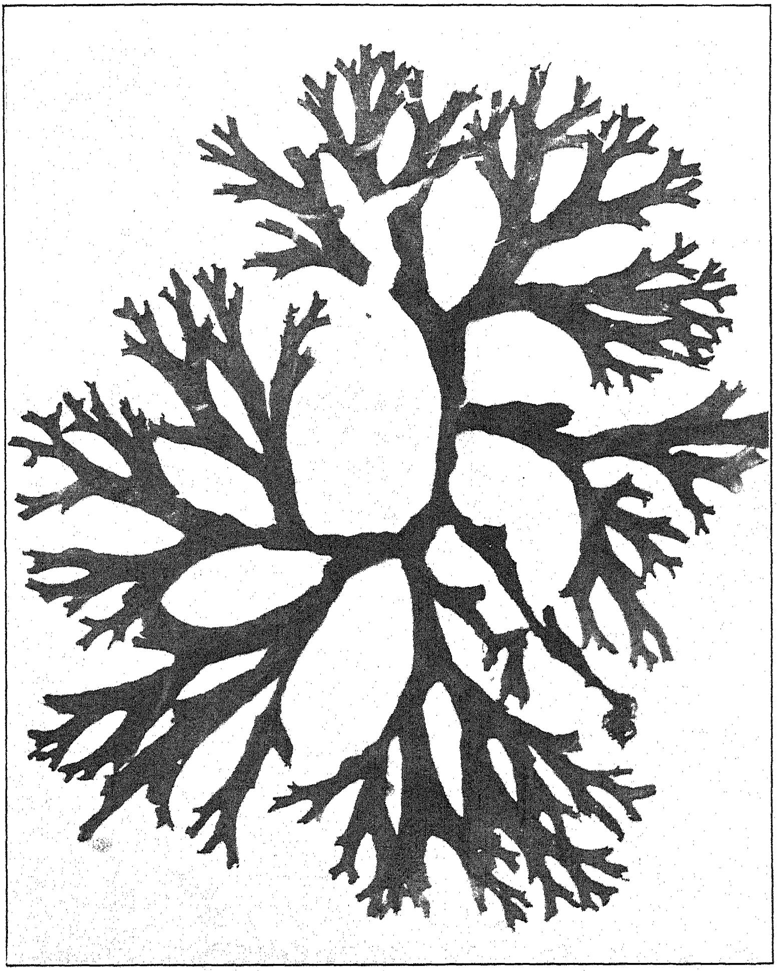

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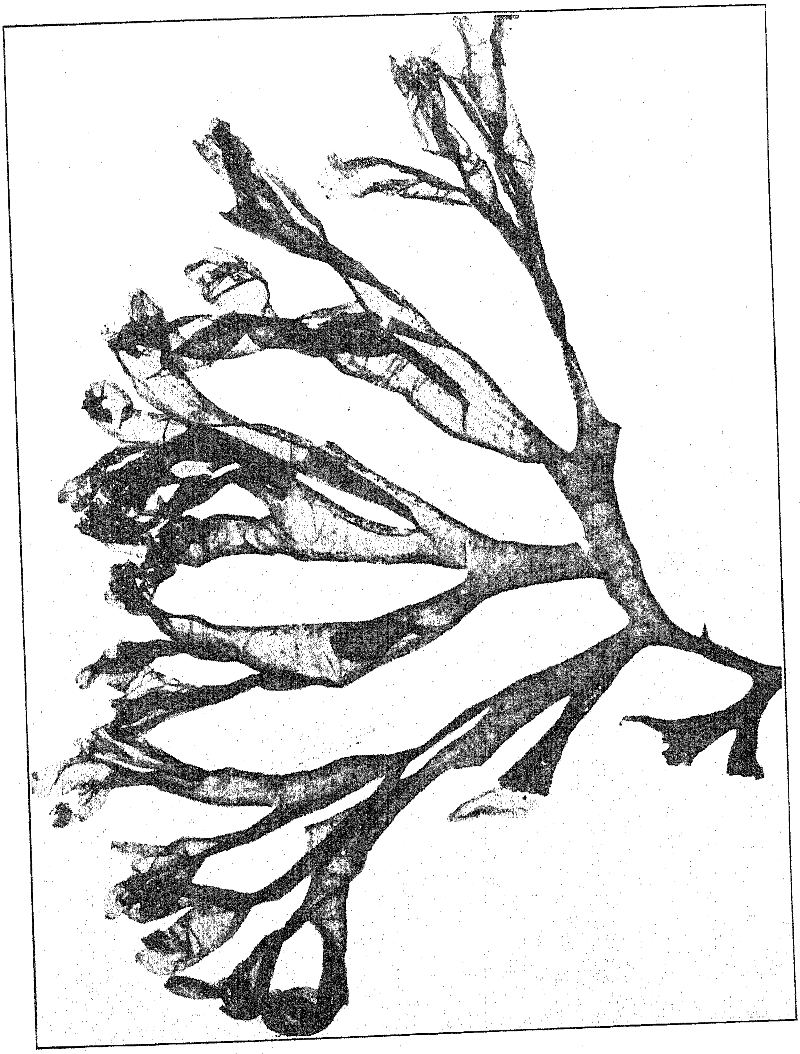

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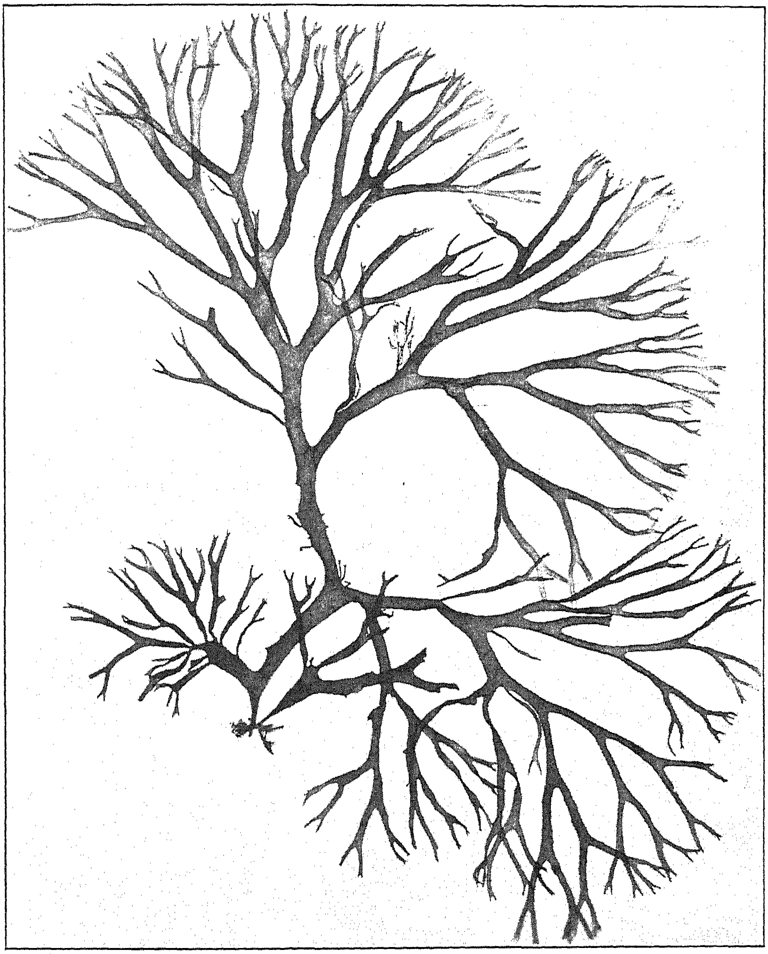

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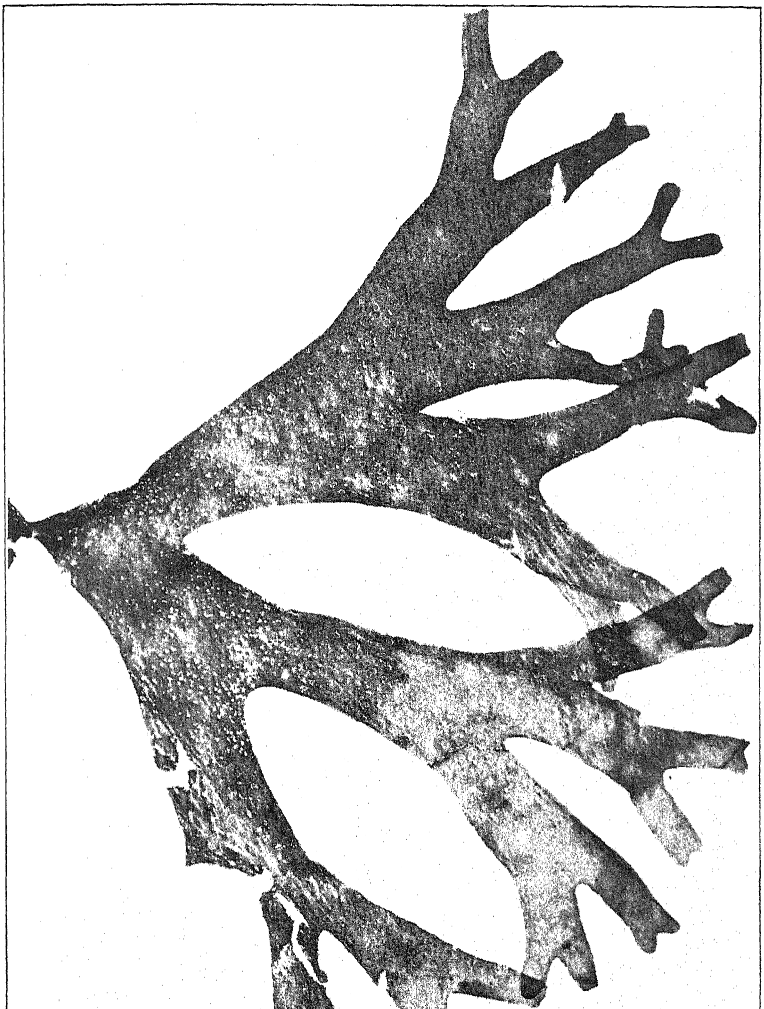
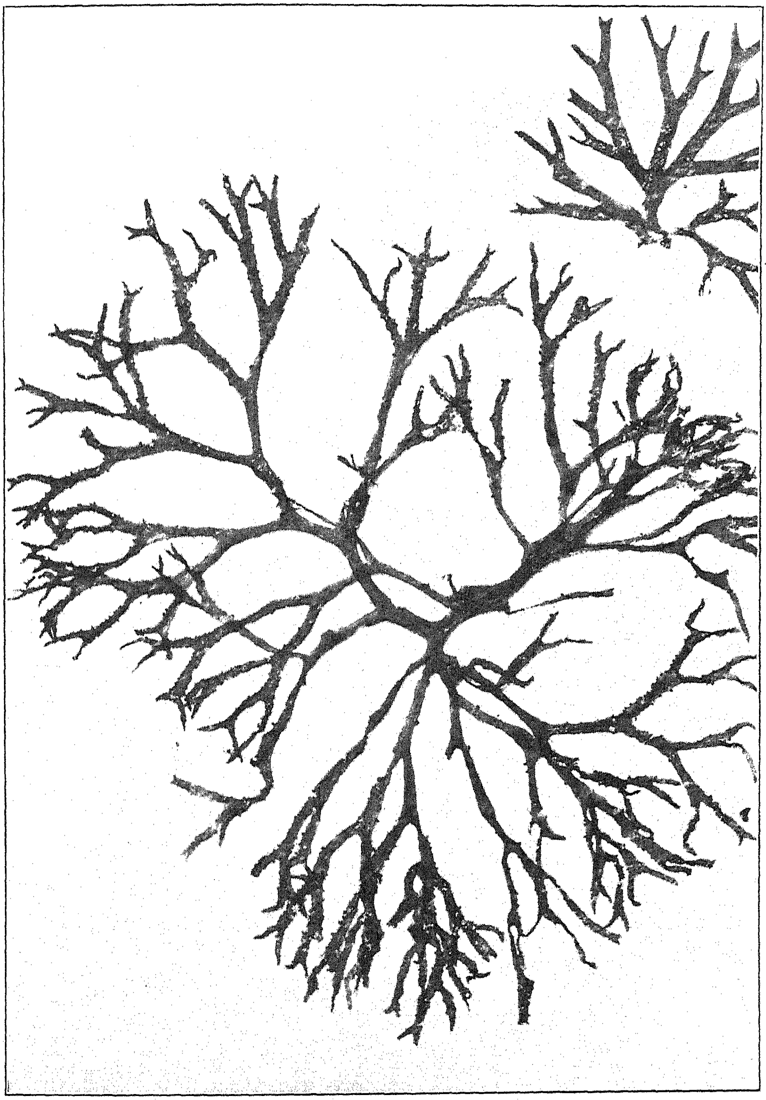


GRACILARIA VIVESII M. A. HOWE



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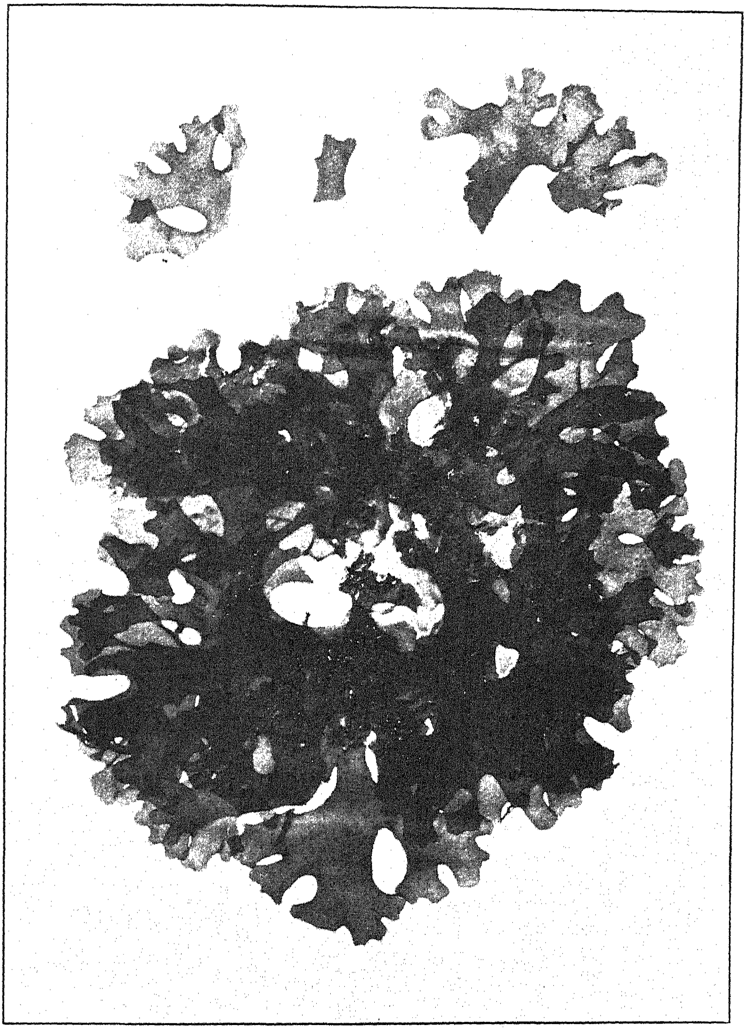

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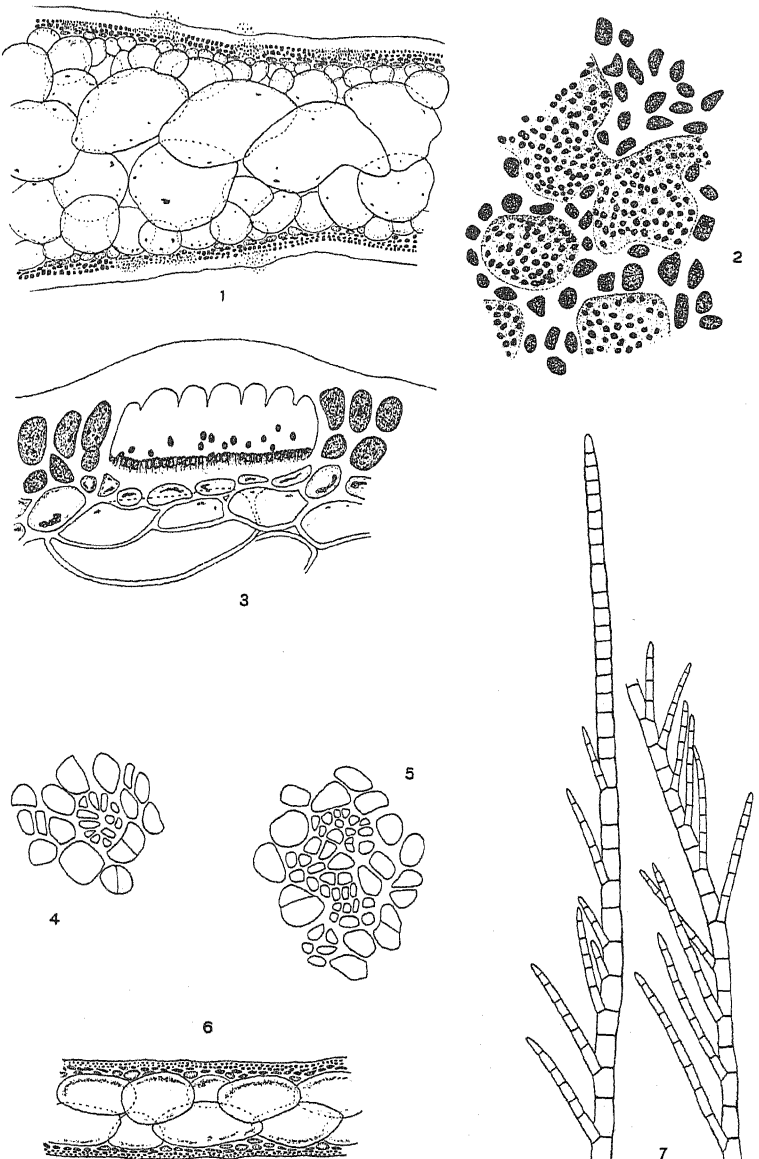
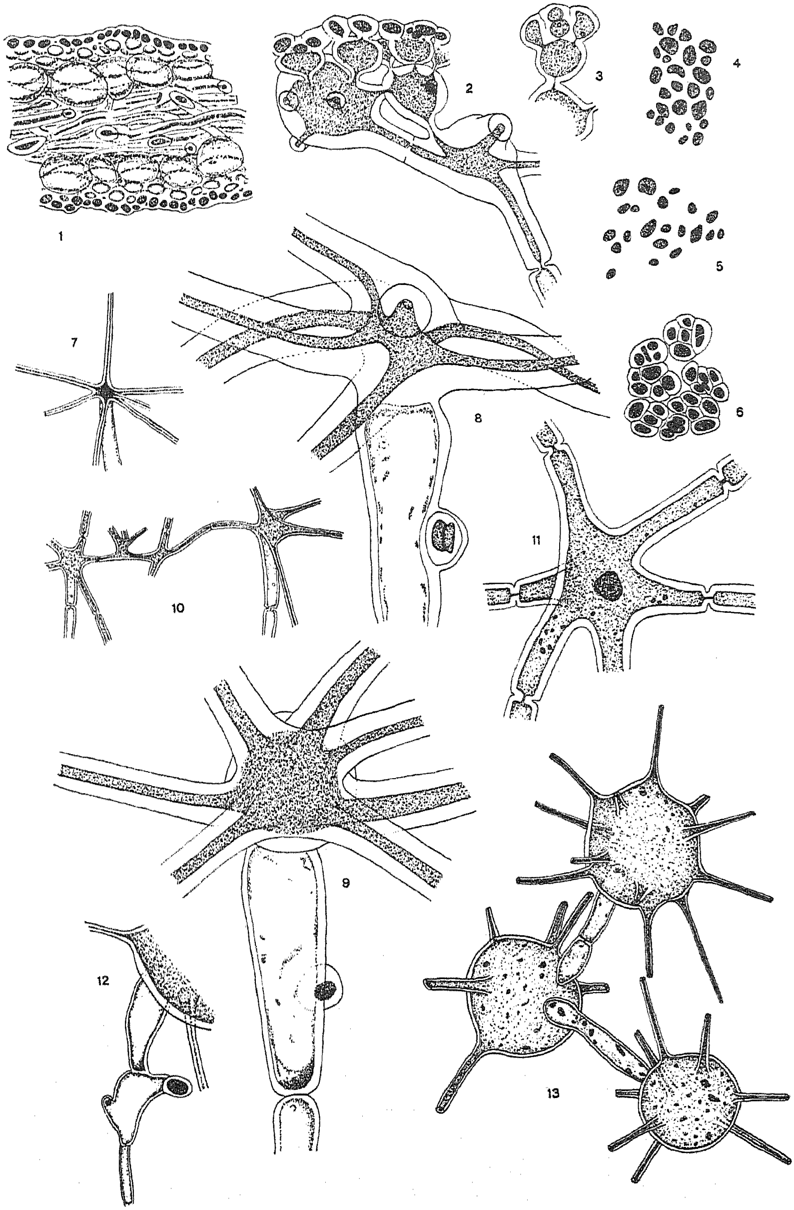


1–5. GRACILARIA VIVESII M. A. HOWE
6. FAUCHEA (?) MOLLIS M. A. HOWE
7. CLADOPHORA MACDOUGALII M. A. HOWE



HALYMENIA ACTINOPHYSA M. A. HOWE

Vol. 38 No 12

BULLETIN

OF THE

TORREY BOTANICAL CLUB

DECEMBER, 1911

Dioecism in the trailing arbutus, with notes on the morphology of the seed

NEIL E. STEVENS

The heteromorphic nature of the flowers of *Epigaea repens* has been the subject of occasional remark ever since the time of André Michaux. In his journal[11] (p. 138) written while exploring in the Alleghany Mountains in 1796, occurs this entry: "Le 2 Avril Epigea repens en pleine fleur comme les jours précedents: sur plusi. individus toutes les fleurs femelles sans rudiments d'Etamines et sur d'autres individus toutes les fleurs hermaphrodites." His Flora[12] (p. 250) contains this further note: "Flores omnes in nonnullis individuis abortivi."

In 1868, Thomas Meehan[10] presented a paper before the Philadelphia Academy of Sciences in which he called attention to the fact that the pistillate flowers have "fine cleft stigmas strongly recurved, exposing a glutinous surface; while the hermaphrodite ones keep the apex of the pistils closed." From this he inferred that the plant was practically dioecious; and an examination of a number of plants during the fruiting season apparently confirmed this belief, for he found that over half the plants set no fruit.

Asa Gray[4] published in 1876 a short article on the floral structure of *Epigaea*, in which he classifies the flowers in two main groups, each with two modifications. The first group is characterized by having well developed stigmas composed of five radiate lobes which are moist and glutinous and evidently well

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adapted for retaining pollen. This first group he subdivides on the basis of whether the stigma projects above the corolla or is included within the tube. In the "shorter styled form," however, the height of the stigma varies considerably, being "sometimes as low as the middle of the tube of the corolla, sometimes nearly up to the throat." This main group is further characterized by having aborted stamens. The stamens of this form show varying stages in abortion, from mere rudiments of filaments to a condition of fully developed filaments bearing anthers with occasional pollen grains. They are, however, always functionless and the form is evidently pistillate.

The second group is characterized by having small, erect, and comparatively smooth and dry stigmas which do not retain pollen readily. The ovaries in this form are apparently as well developed as those in flowers of the first group, and the styles show the same variations in length. This small stigma form has well developed stamens with anthers that abound in pollen. The stamens vary much less in length than do the pistils but there is "a tendency to having lower instead of higher anthers in connection with the short style." In conclusion Gray raises the question as to whether *Epigaea* is really dioecious or the small stigma form sometimes sets fruit; and suggests that the modifications in the length of the style point toward a heterostylous condition like that of the primroses.

Since Gray's time several papers dealing with the flowers of *Epigaea* have appeared. All of them agree in most particulars with his observations. Halsted[6] found all the kinds of flowers described by Gray, and notes that about one third of the flowers of the small stigma form have the stigmas even with the anthers. He measured the pollen grains from the longer and shorter stamens and found no difference in their size. As a difference in the size of the pollen of the different forms is common among heterostylous plants Halsted concludes that *Epigaea* shows no real evidence of heterostyly.

Wilson[15] examined a thousand plants, mostly from North Carolina. He found that the kind with perfect stigmas showed all gradations in length of style from the longest to the shortest. In only one of these large stigma plants did he find even aborted

anthers. In the kind with pollen-bearing stamens he found the same variations in length of pistil and an equal variation in length of stamen. The two organs do not show any correspondence in length, however, but all lengths of stamens are found associated with each length of pistil. Wilson concludes that the pistil in this form is functionless because of its imperfect stigma and that the species is really dioecious; and he makes the interesting observation that the flowers of the two forms differ, the corolla being from one third to one seventh smaller and generally more pink in the large stigma form than in the small stigma form. He also considers that *Epigaea* must have been trimorphic before becoming dioecious.

Miss Langdon[9] examined a large number of flowers and found all the types described above. She notes that several arrangements of anthers may occur with each length of stigma, and that while usually all the flowers of a cluster are of the same form occasional exceptions occur. For example, on one spray there was a cluster of medium-styled flowers and one of short-styled; and in one short-styled cluster was one long-styled flower. Bastin[1] in a paper on the structure of *Epigaea*, discusses the flowers but all his observations on this point are taken from Wilson's article.

The peculiar condition of the flowers of *Epigaea* was brought to the writer's attention, in connection with some work on heterostylous plants, by Gray's suggestion that *Epigaea* might be an example of a heterostylous species that either was approaching or had attained a dioecious condition. As will be noted from the papers cited above, there is considerable uncertainty as to whether *Epigaea repens* is really dioecious, that is, whether in the form having perfect stamens the pistil is incapable of producing seed; and as to whether there is any real evidence of a heterostylous condition. The writer has accordingly investigated these two points. In connection with this work, flowers from several localities in New England and New York have been examined, and a number of plants taken up and cultivated for experimental purposes. The writer wishes to acknowledge his indebtedness to friends who have sent him specimens and to Mr. F. V. Coville for generously sending information as to his methods of cultivating the plant.

EVIDENCE OF HETEROSTYLY

The claims as to heterostyly in *Epigaea* are based entirely upon the variation in the length of the pistils As Darwin[3] (p. 3) emphasized, however, in his original discussion of heterostylous plants, anatomical characters alone do not furnish conclusive evidence of heterostyly. The essential differences between the forms of a heterostylous species are physiological differences in the pistils and pollen. Unless it be proven that one form is wholly fertile only when pollinated with pollen from another form, we do not have conclusive evidence that the species is heterostyled.

In *Epigaea*, moreover, the anatomical evidence is anything but conclusive. Gray (loc. cit. 75), to be sure, divides the large stigma kind into two groups distinguished by different lengths of style, but there are all gradations from the longest style to the shortest (Wilson, loc. cit. 59). The small stigma form shows even less evidence of heterostyly, for both styles and stamens show all gradations in length and the stamens vary within much narrower limits than do the pistils (Gray, loc. cit. 75). And in place of the correlation of pistils of a given length with stamens of a different length characteristic of heterostylous flowers, we find in *Epigaea* any length of stamen associated with any length of pistil (Wilson, loc. cit. 59, and Miss Langdon, loc. cit. 11); and flowers with stigmas at the anther level are common (Halsted, loc. cit. 249). Moreover, as Halsted points out, the pollen grains from the stamens of different lengths show no difference in size; and this, while by no means conclusive, lessens the probability that the species is truly heterostylous. All these observations have been confirmed by the writer.

Experiments, however, show still more conclusively that *Epigaea* cannot be considered a heterostylous plant. The writer transplanted several wild plants with large stigma, each of which bore a dozen or more buds, and cultivated them out of doors. The plants apparently suffered no injury and all blossomed readily. While the pistils showed a wide variation in length they may be roughly classified as long-styled, mid-styled, and short-styled forms. Flowers of each of these forms were pollinated with pollen from long and mid-length stamens. No flower with stamens

corresponding in length to the shortest pistils has been found by the writer.

The pollen germinated readily, and sections made twenty-four hours after pollination showed the stigmas crowded with pollen tubes. The tubes, however, developed rather slowly, and it was only at the end of five days, 120 hours, that pollen tubes were found extending to the ovules, and in a few cases the polar nuclei appeared about to fuse with the male nucleus. It is noteworthy that the pollen from both lengths of stamens germinated with equal readiness on all lengths of pistil. Such would not be the case, of course, in a truly heterostylous plant.

DIOECISM

The evidence as to dioecism is much more satisfactory. Unquestionably the large stigma form is uniformly pistillate, for usually only mere rudiments of filaments appear and often none at all. Gray (loc. cit. 74), however, found in some anthers in a flower of this form a few "perhaps well formed pollen grains," but the anthers never opened. In the one thousand plants examined by him, Wilson (loc. cit. 59) found only one large stigma plant that showed even aborted anthers. The writer examined over two hundred plants of the large stigma form, and only three bore flowers with any rudiments of anthers. Microtome sections of these flowers were prepared, and while the four locules could in some cases be distinguished they contained merely masses of broken down cells.

The form with well developed stamens, on the other hand, has never been observed to set fruit; and as Gray (loc. cit. 76) points out, it is easy to ascertain in any case which kind of flower has matured fruit, because the style and stigma persist until the fruit is fully mature. Indeed, in the flowers in which the ovary has not developed, the style and stigma often persist for over a year, somewhat shrunken, to be sure, but still sufficiently well preserved to make it certain to which form the flower belongs. This unusual persistence of the style and stigma seems to be due to the fact that the carpellary bundles contain strongly lignified tracheids.

The pistil of this form, however, is, as Gray (loc. cit. 75) observed, apparently normal except for its smaller and rather

dry stigma. The writer experimented with the artificial pollination of this small stigma form both with plants cultivated in pots and with flowers kept in water. The pollen adheres to these stigmas to a considerable extent, though this is probably due to the fact that the wall of the pollen grain is somewhat mucilaginous, for the pollen adheres also to the style below the stigma and even to smooth objects, such as a glass rod. In no case, however, was a pollen grain observed to develop a tube when placed on a stigma of this kind. The pollen was retained without degeneration for some time, frequently for over a week, but it never established any organic connection with the pistil and could easily be brushed off. As these cultivated plants appeared perfectly healthy and afterward developed apparently normal new shoots, the failure of the pollen to germinate cannot be attributed to any unusual weakened condition of the pistils. Moreover, the same condition was found to occur in long-styled plants of the small stigma form growing under natural conditions. Although the stigma in these plants projected well above the stamens it was covered with pollen, probably as the result of the visits of insects. Not a single grain, however, had emitted a tube.

This evident sterility of the pistils in the staminate form seemed still more remarkable when microtome sections of the ovules were examined. At the time of fertilization the embryo sac of the large stigma form shows uniformly typical egg and synergids, well defined antipodal cells, and the two polar nuclei lying close together near the middle of the sac. In all probability it remains in this condition over winter (Coulter and Chamberlain,[2] p. 53). The ovules of the sterile small stigma form present an identical appearance both in size and in the condition of the embryo sac. It is of course possible that the nuclei of this functionless embryo sac have not undergone a reduction division. There appears to be no evidence, however, of a tendency toward apogamy, and these unfertilized ovules gradually degenerate.

We have then, in the small stigma form of *Epigaea*, flowers that are apparently perfect but functionally male. The morphological differences between the functional and non-functional pistils in this species are, as pointed out above, very slight and are confined to the stigmas. Their physiological differences are so

great, however, that pollen which germinates readily on the stigmas of one form is absolutely inert on those of the other, and *Epigaea repens* is functionally a dioecious plant.

A few other cases of plants that are apparently polygamo-dioecious but actually dioecious have been observed. Darwin (loc. cit. 288) noted that the "hermaphrodite" flowers of *Euonymus europaeus* are practically male, so this species is really dioecious. Mottier[13] (p. 377) and von Kirchner[8] (p. 116) have pointed out that the apparently polygamodioecious maples are functionally dioecious, because the anthers of the "perfect" flowers, although they contain some apparently normal pollen grains, never open.

Celastrus scandens is an apparently polygamodioecious plant, having pistillate and "perfect" flowers. Like the related *Euonymus europaeus*, however, it is dioecious in function, for the pistils of the "perfect" flowers are smaller than those of the pistillate and appear upon investigation to be non-functional. *Celastrus* is abundant in the vicinity of New Haven, Connecticut, and during the spring of 1911 the writer examined a large number of plants in this region. Particular care was taken to observe the plants bearing "perfect" flowers. Not only was there no indication of any development of the ovary but the flowers shriveled and dropped from the plant almost as soon as the pollen was shed. Microtome sections showed that the ovules in the pistillate flowers are more than ten times as large as those of the "perfect" flowers. Many of these non-functioning ovules contain, however, an apparently typical embryo sac.

The condition found in the maples is exactly the reverse of that found in *Epigaea* and *Celastrus*. In the latter species there are two kinds of flowers, one evidently pistillate, the other developing both ovules and pollen grains. In some species of maples, on the other hand, one kind of flower is evidently staminate and the other apparently perfect. In *Epigaea* and *Celastrus*, however, the ovules of the "perfect" flowers are never fertilized, and in the maples the anthers of the "perfect" flowers do not open. Notwithstanding their morphological differences, then, both types are functionally dioecious.

As Wilson (loc. cit. 59) states, there is in *Epigaea repens* an apparently constant difference in size between the large-stigma

and small-stigma flowers. If flowers of the two forms growing in the same locality are compared, the pistillate flowers seem to be uniformly smaller than the apparently perfect flowers. Darwin (loc. cit. 307) considers that this is generally the case in gynodioecious plants, and names a dozen such species in which the pistillate flowers are smaller than the staminate flowers. He notes also the fact that no such difference in the size of the corolla has been found in the two forms of androdioecious species.

The writer has been unable to demonstrate, however, any correlation of color of the corolla with the two forms of stigma. Wilson (loc. cit. 59) states that the corollas of the large stigma flowers are pink, while those of the small stigma flowers are white. This is apparently true in some localities; but in one lot of flowers sent from a locality in Maine nearly all the flowers of both forms were pink. Moreover, a small lot of flowers from New Hampshire showed the large stigma flowers small and white, while the small stigma flowers were larger and very deep pink.

Morphology of the Seed

In the sections made for the purpose of determining the rate of growth of the pollen tubes several points were noted which seemed worthy of record, and the development of the seed has

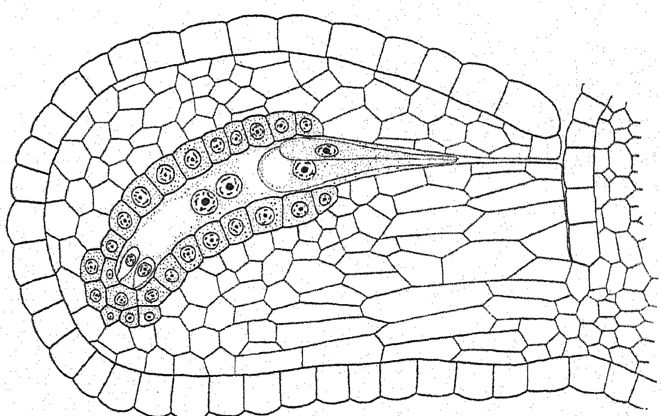


Fig. 1. Longitudinal section through ovule of small stigma form of *Epigaea repens* showing "tapetum" surrounding the lower portion of the embryo sac, elongated egg and synergid, saclike antipodal cells and polar nuclei. This ovule though non-functional is identical in appearance with the functional ones. ×400.

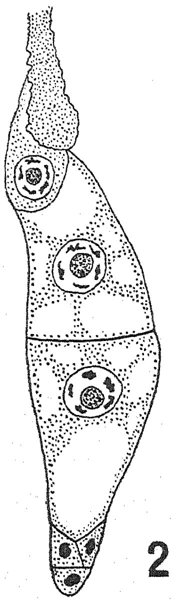
accordingly been traced. The mature embryo sac (FIG. 1) presents no unusual features except that it is somewhat curved and is prolonged, toward its micropylar end, into a narrow funnel-shaped region which contains the greater part of the egg and synergids. The nucellus either does not persist or else it coalesces so completely with the integument that they appear continuous.

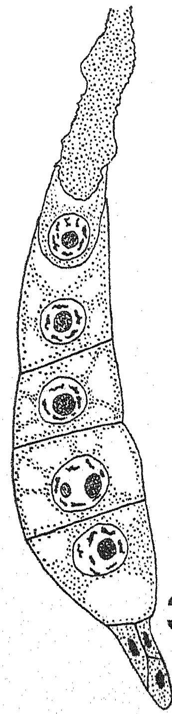
The single massive integument, which makes up the bulk of the ovule, is differentiated into three rather definite regions: the epidermis, a middle storage region, and an inner tapetal region surrounding the embryo sac. The cells of the epidermis are large, regular, and rather thick-walled. The storage region shows little differentiation except that the cells in the funicular region are considerably elongated. The "tapetum" is composed of a single layer of cells except at the antipodal end, where it is usually two or more cells in thickness. Its cells have the large nuclei and dense granular cytoplasm characteristic of nutritive cells. It is noteworthy that the tapetum does not surround the narrow micropylar portion of the embryo sac, a fact which suggests that the micropylar portion may be a secondary development due to an encroachment of the growing egg and synergids upon the tissues of the integument.

As noted above, at the time of maturity of the embryo sac the polar nuclei lie close together in the middle of the sac. They remain entirely distinct, however, until fertilization occurs and the primary endosperm nucleus is formed by the simultaneous fusion of the polar nuclei with the male nucleus. The division of the primary endosperm nucleus is accompanied by the formation of a transverse wall dividing the embryo sac into two approximately equal chambers (FIG. 2). Each of these chambers is further divided by a cross wall resulting in a "four-chambered" embryo sac (FIG. 3). No division of the fertilized egg has occurred at this stage.

In the further development of the endosperm, cell divisions occur rapidly in all four of these "chambers." The cell divisions take place in various planes, and by the time the proembryo contains five or six cells it is impossible to distinguish the original cross walls which separated the four chambers of the embryo sac. There is thus no period of free nuclear division in the development of the endosperm in *Epigaea*.

Instances in which the first division of the primary endosperm nucleus is followed by the formation of a transverse wall across the embryo sac, are fairly common especially among the Sympetalae (Coulter and Chamberlain, loc. cit. 176); and the formation of a two-chambered embryo sac has been reported in the three subfamilies most closely related to the Ericoideae, that is,





FIGS. 2 and 3. "Chambered" embryo sac of *Epigaea repens*. ×600.
FIG. 2. Two-celled stage.
FIG. 3. Four-celled stage. The fertilized egg is partly covered by the remains of the pollen tube, and the antipodal cells have largely degenerated.

in the Pyroloideae, Monotropoideae, and Vaccinioideae (Hofmeister,[7] p. 141). The later development of the endosperm differs somewhat in the different groups. In the Vaccinioideae the endosperm is reported to develop only in the antipodal chamber while in the Pyroloideae and Monotropoideae endosperm is formed in both chambers. The only case in which, as in *Epigaea*, the embryo sac becomes divided into four superposed chambers all

of which take part in the development of the endosperm, is that of *Datura laevis* reported by Guignard[5] (p. 166).

A "four-chambered" embryo sac, formed, however, somewhat differently from those of *Datura* and *Epigaea*, is found in *Physostegia virginiana*. In this species Sharp[14] (p. 220) has recently observed that the division of the primary endosperm nucleus is accompanied by the formation of a longitudinal wall running through the middle of the embryo sac. The nuclei of the two resulting parts of the sac then divide and transverse walls are

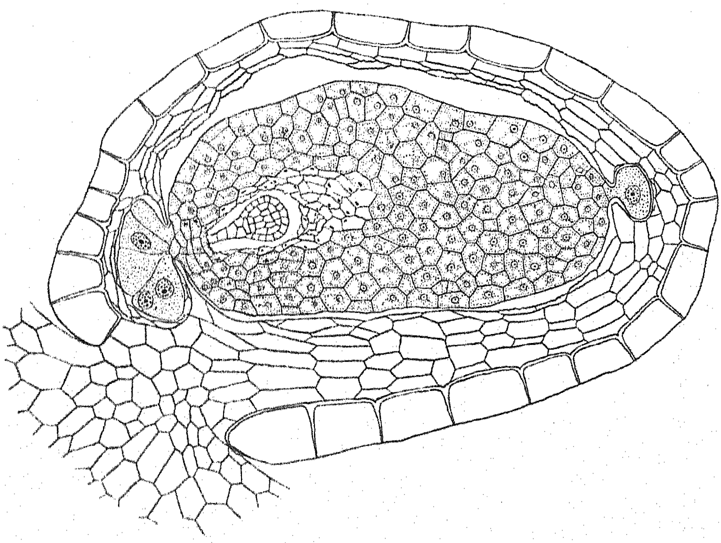


FIG. 4. Longitudinal section of developing ovule of *Epigaea repens*, showing haustoria which function for the nourishment of the endosperm. ×190.

formed. Further transverse divisions then give rise to a large-celled thin-walled tissue which fills the "endosperm lobe."

By the time the embryo of *Epigaea* reaches the quadrant stage the endosperm has a very considerable bulk and shows in longitudinal section fifty or more cells. At about this stage a knobshaped projection appears at either end of the endosperm. These outgrowths extend into the tissues of the integument and apparently function as haustoria to nourish the developing endosperm.

At first both haustoria consist of but a single large cell; and this is usually the condition of the antipodal haustorium at

maturity. In the formation of this cell a portion of one of the peripheral cells of the endosperm grows out into the tissues of the integument, increases greatly in size, and is later cut off by a cross wall. By the continual growth and division of the cell thus cut off, the micropylar haustorium develops rapidly until finally it consists of a group of eight or ten cells having dense granular contents and large nuclei. Frequently some of the cells of this haustorium contain two nuclei. The condition shown in FIG. 4 represents about the maximum development of the haustoria, and in the nearly mature seed they appear crushed and distorted among the tissues of the integument.

Haustoria of various kinds that function for the nourishment of the endosperm have been reported in numerous instances. Their occurrence and origin, together with the whole subject of the nourishment of the developing embryo sac, have been discussed by Coulter and Chamberlain (loc. cit. 104–113). They mention haustoria of various forms, developed from the micropylar and chalazal ends and even from the sides of the sac. Sometimes the haustoria develop from protrusions of the sac itself; but in other forms the synergids, the antipodal cells, the suspensor, and one of the row of megaspores have been reported to take part in the formation of haustoria. The structures found in *Epigaea* are noteworthy as rather simple haustoria which originate directly from the endosperm at a comparatively late stage in its development.

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On the identity of Cyathea multiflora, type of the genus Hemitelia R. Br.*

WILLIAM R. MAXON

(WITH PLATE 35)

The genus *Hemitelia* was established by Robert Brown in 1810 for a group of tree ferns, of which the following previously described species were known to him and were stated as representatives of his new genus: (1) *Cyathea multiflora* Sm., (2) *C. horrida* Sm., and (3) *C. capensis* Sm. Fortunately these are now regarded, as they have been generally in the past, as congeneric. If, then, the genus *Hemitelia* is to be recognized as valid, there can be no objection to a selection of the first-named species, *Cyathea multiflora*, as its type. This course has been followed in recent years by both L. M. Underwood† and C. Christensen,‡ and has been tacitly accepted, although quite a different typification of the genus was long ago proposed by G. Gardner.§

Concerning the identity of *Cyathea multiflora*, however, there has been little but confusion, almost from the time of its publication. Following a brief description (quoted from Willdenow) Hooker commented upon this species in the Species Filicum‖ as follows:

> "Hab. Jamaica; ex Herb. Banks. (*Smith*).—With this I am unacquainted, and Mr. Brown is the authority for its being referred to *Hemitelia*. Sir Jas. Smith, with whom the species originated, has merely said of it (under *Cyathea*) 'Caudice ——, fronde bipinnata pinnatifida, laciniis obtusis serratis, rachi alata, floribus sparsis, calyce lacero.' Willdenow, who seems to have been acquainted with the species, and whose character I have given above, further remarks upon it, 'Rachis margined on each side with a narrow decurrent line. Partial pinnæ 2 feet long. Pinnules 4 inches long, an inch broad at

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† Mem. Torrey Club 6: 268. 1899.

‡ Index Fil. XVII. 1906.

§ London Journ. Bot. 1: 438–442. 1842.

‖ Sp. Fil. 5: 32. 1846.

the base, lanceolate, acuminate, pinnatifid. Segments 5 lines long, oblong, rather acute, obtusely serrated.' Unfortunately neither Smith nor Willdenow alludes to the venation, nor, except the brief notice of the former, to the involucres. Mr. Smith, who, as well as Mr. Gardner, has examined the original specimens, says that, as far as can be judged from the imperfect specimens, it differs from the preceding (*H.? Parkeri*) only in wanting the coarse hairs on the rachis. Mr. Gardner considers it allied to *Alsophila capensis*."

It may here be noted that Willdenow in all probability had not seen the original specimens of the species. His description,* which very greatly modifies and extends Smith's original diagnosis, is thus one of the earliest misapplications of the species-name and is apparently the principal false basis from which so great an amount of misunderstanding has since arisen.

Smith's comment upon the source of his specimens, "Habitat in Jamaica; ex herb. Banks," led Dr. Underwood to look up the actual type of the species in the collection of Sir J. E. Smith at the rooms of the Linnean Society of London, a few years ago. He examined also the original specimens in the Banksian Herbarium (now preserved in the British Museum, Natural History), from which the three pinnæ of Sir J. E. Smith's herbarium had been derived. His conclusion was that the specimens of the two collections, which are identical, represent a species otherwise unknown. Concerning the original source of the material he has written (in MS.), "Jamaica, *R. Shakespeare*. Known only from plants collected in Jamaica in the last of the 18th century."

More recently the writer has received through the kindness of A. B. Rendle, F.L.S., Keeper of the Herbarium of the British Museum, a photograph of Banks's original specimens in the British Museum, here shown in PLATE 35, and with this two pinnules of the plant itself. A transcript of the data attached to the specimen, as shown by the photograph, is as follows:

"Shakespeare, Robert, (fl. 1780–82). Collected in
Jamaica (Hb. Banks).—10. 7. 1903. Prof. L. M.
Underwood called to see this type (?); hence the
difficulties.— ? Can this specimen be the *type* of
Hemitelia multiflora R. Br. Fl. Nov. Holl. p. 158.

* Sp. Pl. 5: 496. 1810.

= *Cyathea multiflora* Sir J. E. Smith in Act. Taur. *5*. p. 416.
= *Amphicosmia multiflora* G. Gardner in London Journ. of Bot. *1*. 1842, p. 441. Cf. this last reference, pp. 438–442. Our plant agrees with Gardner's description, p. 439.—
But Sir J. E. Smith says 'Jamaica, ex herb. Banks' (fide Hook. Sp. Fil. *1*. 32), while *our specimen* bears '*America merid. R. Shakespeare.*' And no other specimen appears to have come from Jamaica. Shakespeare did collect in Jamaica about 1780. If this is the type, the locality 'Jamaica' may be at fault."

From a careful comparison of the two pinnules sent, and of the photograph, with the large series of specimens in the U. S. National Herbarium, the following statements may safely be made:

1. The original specimens in the Banks Collection, British Museum, from which the three type pinnæ of *Cyathea multiflora* J. E. Smith were taken, are from a rather small frond of a species described later upon Central American material as *Hemitelia nigricans* Presl.

2. Smith's statement of the type locality of *C. multiflora* as "Jamaica" is without much doubt erroneous, since: (*a*) The original Banks specimens are marked as from "America merid."; (*b*) in all the botanical exploration carried on subsequently in Jamaica the species has not been there collected; (*c*) *Hemitelia nigricans* is a widespread though not very common species of the Atlantic coast of the mainland, extending from Guatemala, through Nicaragua to Costa Rica and Panama (and in all probability farther, along the northern coast of South America), and may reasonably be supposed to include specimens gathered by chance at almost any point along the Atlantic coast mentioned. Even if there were no confusion as to the locality for the original specimens of *C. multiflora*, their identity with *H. nigricans* can not be questioned, as the following notes are intended to make clear.

Hemitelia nigricans was described in 1849* by Presl from specimens said to have been collected by Friedrichsthal "upon the banks of the river San Juan, in Guatemala." Fournier, however,

* Presl, Epim. Bot. 31. 1849.

has stated* that the locality is in Nicaragua. There is at hand a pinnule from Presl's type at Prag, and also a pinnule of Levy's 468 from Nicaragua, mentioned by Fournier. A close comparison of these with the pinnules of *C. multiflora* from the Banks herbarium shows all three collections to be of the same species and, curiously enough, to give no indication of the variation in size and venation which exists in the more ample material of later collections. In all three the veins are almost without exception simple, and the pinnules only from 3 to 4 cm. long. Recent specimens show pinnules up to 7 cm. long and many of the veins to be once forked at or beyond the middle. From minute characters, nevertheless, it is apparent that all are referable to a single species, which naturally must bear the name *Hemitelia multiflora*. The species has since been described from Costa Rican specimens as *Alsophila decussata* Christ. It is doubtful also if *Hemitelia Hartii* Baker,† from Panama, can be maintained as a distinct species. *Hemitelia obscura* Mett.‡ is a related species described from Colombia, very similar in form, but differing conspicuously in having the lower surface of the costae strongly hispid.

From the whole series at hand, but especially from specimens collected recently by the writer in Panama, the following description has been drawn:

HEMITELIA MULTIFLORA (J. E. Smith) R. Br.; Spreng. Syst. Veg. 4: 126. 1827

Cyathea multiflora J. E. Smith, Mem. Acad. Tur. 5: 416. 1793.
Amphicosmia multiflora Gardner, London Journ. Bot. 1: 441. 1842.
Hemitelia nigricans Presl, Epim. Bot. 31. 1849.
Alsophila decussata Christ in Pittier, Prim. Fl. Costar. 3: 41. 1901.

Caudex erect, 1 to 5 meters high, very slender (about 3.5 cm. in diameter), usually sheathed by the closely ascending or semiadnate fibrous bases of old fronds, or these slowly deciduous, the scars spaced, oblong-elliptic, 4 to 5 cm. long, less than 1.5 cm.

* Bull. Soc. Bot. France 19: 261. 1872.

† Journ. Bot. 24: 243. 1886.

‡ *Hemitelia obscura* Mett. Ann. Sci. Nat. V. 2: 264. 1864. Subsequently figured by Karsten, Fl. Colomb. 2: *pl. 197. f. 2.* 1869.

broad; fronds spreading, 1.3 to 2.1 meters long; stipe up to 45 cm. long, curved, light brown, sulcate ventrally, noticeably brownish-pubescent, freely armed with straight or slightly curved spreading spines 3 to 5 mm. long, and clothed toward the base with deciduous ovate-lanceolate attenuate glossy bright-brown scales 1.5 to 2 cm. long with narrowly erose paler margins, similar scales rather densely clothing the crown and upper part of the caudex; lamina 1 to 1.7 meters long, 60 to 100 cm. broad at the middle, ovate, deeply tripinnatifid, abruptly acuminate, the primary rachis scantily aculeate near the base, upward sparsely muricate or smooth, stramineous-brownish, antrorsely brownish-strigose upon the upper side, below closely beset with stiffish mainly retrorse subpersistent yellowish hairs; pinnæ articulate, 14 to 17 pairs, approximate, the basal ones horizontal or usually deflexed, opposite and relatively short (25 to 32 cm. long, 8 to 11 cm. broad), elliptic-oblong, petiolate (1.5 to 3 cm.); middle pinnae larger, alternate, widely spreading, exactly linear-oblong, not narrowed at the base, 30 to 50 cm. long, 7 to 14 cm. broad, sessile or subsessile, abruptly acuminate-caudate, the secondary rachis like the primary, in the outer part delicately foliaceo-marginate; pinnules 20 to 24 pairs, articulate, deciduous, mostly spreading at right angles, slightly separated or half their width apart, all but the lowermost strictly sessile, linear-oblong, 3 to 7 cm. long, 9 to 18 mm. broad, acutish or rarely acuminate, regularly pinnatifid two thirds to four fifths the distance toward the slender elevated costa; costae yellowish-strigose above, below bearing a few minute deciduous yellowish brown subbullate attenuate scales, glabrous or minutely setulose; segments 9 to 12 pairs, slightly oblique, straight or slightly falcate, oblong, close, the margins plane or lightly revolute, crenate-dentate, strongly so at the very obtuse or sometimes muticous apex, the sides nearly parallel; costules bearing 2 to 4 stiff spinelike hairs above, below glabrous or obscurely and minutely setulose; veins wide-spreading, 4 to 8 pairs, simple or once forked at or beyond the middle, dark, more or less concealed, extending to the margin; sori 1 to 4 pairs, mostly medial, the lower ones supramedial, borne at or just below the fork; indusium proximal, brown, membranous, cucullate-dimidiate, finally somewhat reflexed and cleft into 2 or 3 shallow lobes, often nearly disappearing with age; receptacle globose, the numerous flaccid paraphyses equaling the sporangia; leaf tissue papyraceo-herbaceous, translucent, very dark green above, much paler below, glabrous.

TYPE LOCALITY: "America meridionalis," *R. Shakespeare.*

DISTRIBUTION: Guatemala, Nicaragua, Costa Rica, and

Panama, ascending to 1,100 meters altitude; also reported from Peru.

Besides the fragment of the Shakespeare type above mentioned the following specimens are in the U. S. National Herbarium:

NICARAGUA: Banks of the Rio San Juan, *Friedrichsthal*. Chontales, in forest, *Levy* 465.

GUATEMALA: Forest near Livingston, at sea-level, June, 1906, *H. von Türckheim* II. 1221. Same locality, February 18, 1905, *C. C. Deam* 483 (determined as *Cyathea arborea*). Same locality, January 18, 1905, *Kellerman* 5080.

COSTA RICA: Forêt à Général, altitude 600 meters, *Pittier* 3344. Fougeraies du Général, vallée du Diquís, altitude 700 meters, *Pittier* 12027 (type collection of *Alsophila decussata* Christ). Cienegas de Cañas Gordas, *Pittier* 10978. Cañas Gordas, altitude 1,100 meters, *Pittier* 10980.

PANAMA: Laguna de Chiriqui and its neighborhood, *J. Hart* 12, 29. Humid forest near Porto Bello, province of Colon, at sea-level, April 7, 1911, *Maxon* 5776.

Finally, it may be pointed out that the small size of the original specimens of *H. multiflora*, and perhaps also of Presl's type of *H. nigricans*, is further due to their having come from the upper part of a small frond. The type fragments of both are exactly matched by pinnules from the apical pinnae of the writer's specimens from Panama (the only apical portions at hand), in which also two other perfectly diagnostic features are evident, namely, the conspicuously winged secondary rachises, and the peculiar long-acuminate apices of the pinnae. Both may be readily observed in the illustration herewith published.

WASHINGTON, D.C.

Explanation of plate 35

From a photograph of the original specimens in the Banksian Herbarium, British Museum (Natural History), from which the type of *Cyathea multiflora* was derived. Collected in "America meridionalis" by R. Shakespeare. About one third natural size.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1905–1911)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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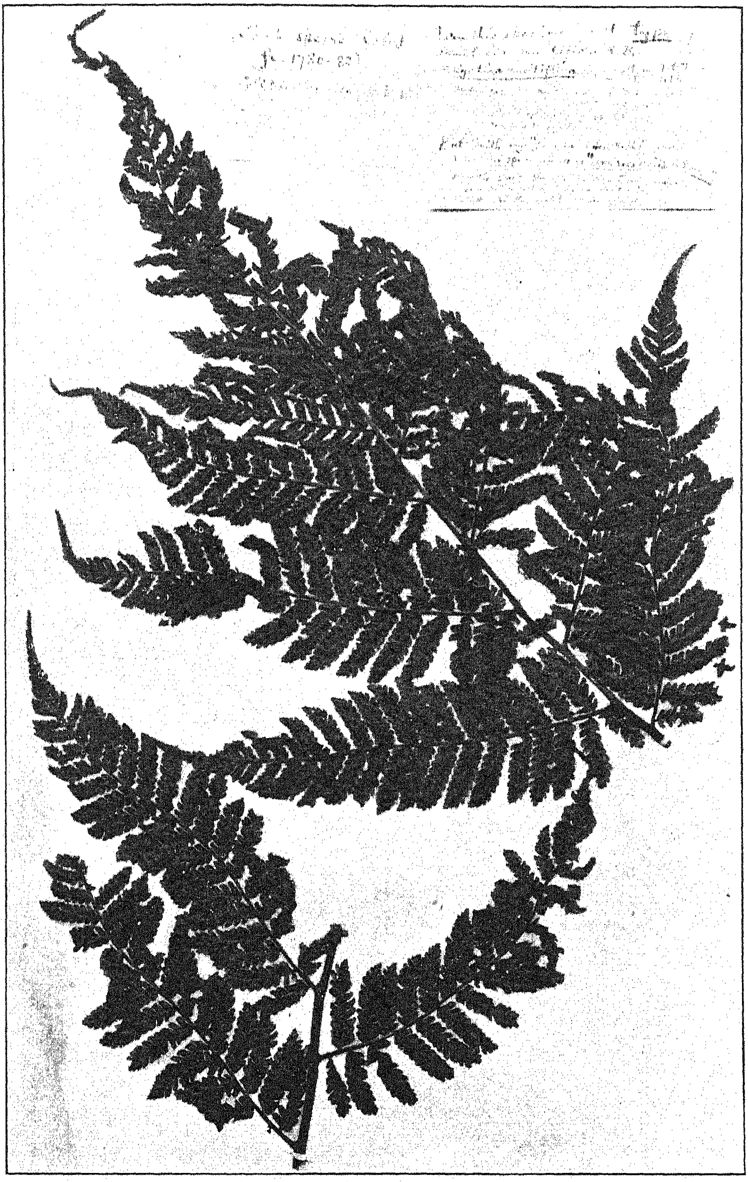

CYATHEA MULTIFLORA J. E. SMITH